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PROCEDURES FOR EVALUATING THE HEARING OF THE MENTALLY RETARDED.

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CENTRAL MICHIGAN UNIV., MOUNT PLEASANT

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APPROXIMATELY 1,300 MENTALLY RETARDED PATIENTS WERE INVOLVED IN A STUDY ON THE ADEQUACY OF HEARING TESTS, THE INCIDENCE OF HEARING LOSS, AND STANDARDIZATION OF PROCEDURES. THE STUDY INCLUDED TEST STANDARDIZATION AND EVALUATION, HEARING SCREENING AND PSYCHOLOGICAL-SOCIAL-OTOLOGICAL EVALUATION, AND HEARING TEST DEVELOPMENT. THE SUBJECTS WHO POSSESSED HEARING DEFICIENCIES UNDERWENT INTENSIVE AND COMPREHENSIVE TESTING PROCEDURES. DATA ANALYSIS INCLUDED TEST-RETEST AND INTERJUDGE SCORES CORRELATION, COMPARISONS, AND ANALYSES OF VARIANCE. THE RESULTS OBTAINED INDICATED--(1) DETECTION OF HEARING LOSS RESPONSES IS DEPENDENT ON THE TESTING PROCEDURE AND THE RESPONSES REQUIRED, (2) TWO CURRENTLY AVAILABLE TESTS FROM THE BATTERY UTILIZED WERE FOUND USEFUL FOR SCREENING, AND (3) DEVELOPED TEST PROCEDURES WERE FOUND UNRELIABLE FROM TEST TO RETEST, BUT POTENTIALLY CAPABLE IF FURTHER DEVELOPED. (RS)

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Cooperative Research Project No. 1731

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DEDICATION

This report is dedicated to the memory of the late Mary A. Soderberg, former head of Social Work at the Mt. Pleasant State Home and Training School, who was, in part, responsible for the initiation of this project.

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SECTION I

PROBLEM, OBJECTIVES, AND REVIEW OF LITERATURE

PROBLEM AND OBJECTIVES

Problem.

The significance of the adequacy of hearing testing of individuals in institutions for mentally retarded appears to be great. Similar behavioral aspects between the group identified as primarily mentally retarded and the group identified primarily as having hearing loss complicate definitive diagnosis on the basis of available evaluational methods. A complicating factor is that after several years in an institution for the retarded, a hard of hearing child can be expected to be educationally and socially retarded. Thus, identification of a hearing loss, even though previously unsuspected, may not appear to be significant in relation to the child's institutional placement. That is, all aspects of his behavior may be retarded due to the hearing loss and/or the effects of the institutional environment. Numerous studies of a survey nature (6,16,26,36,37,40,43) indicated that a sizable group existed in institutions for retarded which could not be evaluated by hearing test procedures currently used. These studies included only the "better" patients and omitted the patients with lower levels of intelligence, the non-trainable, the very young, the blind, the bedridden, the physically disabled, and those with behavioral disorders.

The population for this research study consisted of patients in residence at the Mount Pleasant State Home and Training School. Approximately 1300 patients were involved in the study. This facility is maintained by the State of Michigan for mentally retarded patients. All ages and both sexes are represented. Patients are committed to this facility by court order on the certification of two physicians. Patients must have the diagnosis of mental retardation prior to admission. Many are admitted with multiple handicaps; for example, with cerebral palsy, blindness, hearing loss, and behavioral disorders. These patients have functional and/or organic mental

retardation as well as one or more of these problems. Although most patients were reported to have had otologic examinations, less than one per cent had audiometric evaluations prior to commitment. Hearing testing had not previously been carried out at the institution except as a pilot project for this study.

The purposes of this study were to: (1) survey the hearing status of the total population of an institution for mentally retarded, (2) to evaluate currently available hearing test procedures on this population, and (3) to develop improved hearing test procedures.

Objectives.

Attempts were made to answer the following questions in regard to the population of a state institution for mentally retarded.

- (1) What was the incidence of hearing loss in this population?
- (2) What proportion of this population was testable by standard pure tone audiometry?
- (3) What new special testing procedures were useful in evaluating further those patients found to have a loss by standard pure tone audiometry and those patients who were untestable by standard pure tone audiometry?
- (4) What were the statistical inferences possible for hearing test procedures employed in testing this population?

REVIEW OF THE LITERATURE

Prior Hearing Surveys on Mentally Retarded Populations.

Considerable research data were available to indicate the high incidence of hearing problems for those able to respond to pure tone or conventional speech audiometry in institutionalized mentally retarded populations.

Kodman (26), in 1958, after surveying seven investigations, believed that the incidence of 30 db or greater losses among the mentally retarded was at least

three or four times the incidence found in public school children.

Schlanger (39), summarizing literature through 1961, commented on the wide range of incidence of loss in institutionalized retarded. He found differences in results which ranged from no hearing loss to an incidence of over 50 per cent. Criteria for hearing loss, intellectual level, test procedures, instrumentation, and examiners were mentioned as contributing to some extent to this variation. Reliability of testing procedures had not been determined in most of the investigations he surveyed. Validity of the tests was criticized since a variety of test procedures was not used and it was thought that results, in many cases, were influenced by examiner judgment. He found very little attention was paid to reporting the amount of training to respond given the subjects.

Schlanger hypothesized that training of the subjects to respond might have significantly influenced results. His investigation along this line found that with a training program and with retesting procedures on 199 subjects (selected from 400 on the basis of whether they were capable of responding to hearing tests) the incidence of loss was 9 per cent. This included four subjects of the 199 who could not be tested at the conclusion of the training program. If these were excluded, an incidence of 7 per cent was obtained. The criteria for hearing loss in his study was 30 db loss at two frequencies in the speech frequency range. Schlanger also utilized speech reception testing and found that if the results of one test or the other were accepted, the incidence of loss dropped to 5 per cent with the 30 db criterion. Schlanger detailed some of the difficulties involved in testing institutionalized retarded. He found that only 154 of 355 institutionalized subjects were capable of being tested by pure tone screening audiometry. He mentioned

that 201 of the subjects were non-testable in any testing situation, including the measuring of responses to tone, noise, and speech. He did not feel it was possible to condition the low grade subjects to respond to hearing testing and subsequently added 32 children from special classes of the county schools. An additional 13 subjects newly admitted to the institution were added after the project was underway. The incidence of hearing loss reported by Schlanger in an institutionalized mentally retarded population is probably inadequately determined for general application. He excluded from further study any child who failed to respond in sweep-screening audiometry to two of the four frequencies tested at 30 db or any child who had invalid responses to pure tone stimuli indicating that the subject was untestable or inconsistent in his responses. On that basis, children with hearing losses of 30 db or greater would have been excluded from his incidence figure.

Johnston and Farrell (22) reported on hearing testing of subjects in the Educational Department at the Fernald State School in Massachusetts. Their procedure involved pure tone testing over the range 250 to 6000 cps. Criteria for hearing loss was a loss of 20 db or more at two or more frequencies. They obtained data on 270 educable children. They did not report the number of subjects rejected from hearing testing. Of those tested, 24 per cent had hearing losses as defined in their study. Sixty-four per cent of these losses were bilateral impairments which they considered severe social and communicative handicaps.

Bradley, et al. (5) attempted testing 208 institutionalized mentally retarded subjects. Nineteen of these were untestable by his pure tone technique. The testable children were divided into two chronological age groups. The younger group (N = 84) had a mean age of 15.37; the older group (N = 105)

had a mean age of 38.70 years. Each subject was screened at 20 db over the frequency range 250 to 8000. Hearing loss criteria were defined as thresholds of 30 db or greater at one or more frequencies in either ear. The incidence of hearing loss for the population tested was 21.43 per cent with a range of 19.04 per cent for the younger group to 23.81 per cent for the older group. Bradley suggested that a battery of tests rather than pure tone testing alone would demonstrate a smaller incidence of hearing loss.

One of the earliest large-scale reports of hearing difficulties in institutionalized retarded was made by Birch and Matthews (3). Their survey, done in 1951 at the Polk State School in Pennsylvania, utilized hearing testing with pure tone audiometers by two graduate students. Their study included the 247 subjects in residence at the school with ages ranging from 2 to 19. They reported 32.7 per cent of the population tested had losses which fell into hearing loss categories where functional hearing difficulty would be encountered.

Siegenthaler and Kryzwicki (43) in 1959 attempted hearing testing on 396 school girls at an institution for retarded females in Pennsylvania. Results indicated 10 were untestable and 317 had normal hearing. Sixty-nine (17.9 per cent of those testable with the audiometer) had some degree of hearing loss. They also tested 342 non-school girls in the same institution and found 152 of these had normal hearing, 12 were untestable, and 78 (33.9 per cent) had some degree of hearing loss. Most of the losses were less than 30 db. Sixteen per cent of the school girls who had hearing losses had better ear average reductions in acuity of 30 db or more. Eighteen per cent of the non-school girls with hearing losses had better ear average reductions in acuity of 30 db or more. It should be pointed out that for the non-school

girls (the group with the higher incidence of hearing loss) if hearing loss was defined as a better ear average acuity of 30 db or more, only 4 per cent of those testable would have been diagnosed as having hearing loss. If the untestable were included, approximately 8 per cent of the group would have fallen in the hearing loss category.

Rigrodski, Prunt, and Glousky (36) surveyed incidence of hearing loss in the population at the Training School in Vineland, New Jersey. They included only a minimal number of custodial cases in their survey. Frequencies tested were 250 to 8000 cycles. A hearing loss was defined as a loss of 20 db or more for any two frequencies in any one ear. Twenty-five per cent of the 325 subjects tested had impaired hearing. Utilizing the audiometric data, they concluded 11 per cent of these were conductive, 44 per cent were perceptive, and 45 per cent were mixed losses. They found a higher percentage of hearing loss in males than females and perceptive and mixed losses were nearly twice as frequent in the male population. They pointed out the necessity of validating their study by the use of other techniques such as psychogalvanic skin response audiometry and ear choice pure tone audiometry.

Schlanger and Gottsleben (40) reported on hearing testing at Vineland Training School in 1956. They tested 498 subjects over the frequency range 125 to 12000 cycles. Training was attempted with a loud tone in order to get the subject used to responding to the sound. The ear choice technique was used where this did not work. Bone conduction testing was administered when a conductive loss was thought to be present. Forty-nine per cent of the population tested had hearing within the normal limits for the speech frequencies while 17 per cent were found to be non-testable. Thirty-five per cent of the total population who were testable had demonstrable hearing losses.

Foale and Paterson (16) surveyed the hearing status of mental defectives in Scotland in 1954. They tested 100 boys aged 10 to 19 years with a mean IQ of 66. They found 13 per cent of their population had a hearing impairment which probably handicapped them in ordinary life activities.

Rittmanic (37) tested 1220 patients (IQ range from 30 to 129) at the Dixon State School in Illinois in 1959. Patients were selected on the basis of ability to respond reliably to a pure tone audiometric screening test. Untestable patients were classified as severely retarded, emotionally disturbed, uncooperative or unwilling, or hospitalized. The criteria for a hearing loss were a loss of 15 db or greater for two or more frequencies tested (250 to 8000 cycles) in one or both ears. On this basis, 40.5 per cent of the subjects had hearing losses which were thought to be significant. Eighty per cent of the hearing loss cases required only conservative medical treatment since their losses were not socially or educationally handicapping. Only 25 subjects less than 10 years of age were tested; hearing loss was found in .4 per cent of this group. Of the 297 subjects tested in the age range 10 to 19, 19.8 per cent were found to have a hearing loss. The group over age 60 had an incidence of hearing loss of 84 per cent. During the six months following the survey, 15 per cent of the hearing defective group were given otological examination, four per cent had wearable amplification (hearing aid) recommended, and three per cent were actually fitted with hearing aids and placed in an aural rehabilitation program.

Summarizing the literature available in regard to hearing surveys of institutionalized retardates, one can only say that hearing loss appears to be more frequent than in the normal population. The number of patients excluded from testing, the criteria for hearing loss, the mental ages of the group

involved, the nature of the tests used, the training of the examiner, the group of patients the institution was set up to serve initially, and the training of the patients to respond have contributed to the extent to which clear definition of this problem has been difficult. Although Schlanger was able to reduce the incidence of hearing loss to 9 per cent following a training program, the initial selection of subjects excluded any subject who did not respond to two frequencies at a 30 db level. Thus, subjects with hearing losses greater than this were excluded from his data. Foale and Paterson and also Siegenthaler and Kryswicki found lower levels of hearing loss in their subjects than is reported by other investigators. This might be explained by the fact that the median IQ of their subjects was possibly higher than other reported research. Their subjects, thus, might have represented a population different than most subjects in institutions for retarded in that they were more able to respond to the demands of hearing testing and therefore did not appear as frequently to have hearing loss. These same investigators pointed out the similarity of the results of hearing loss and the presence of mental retardation. Perhaps a good estimate of the extent of hearing loss in the institutionalized retarded population as reported in the literature is that approximately 20 per cent of this group could be expected to have hearing losses for speech reception of 20 db or more. Although this did not agree closely with those studies reporting 30 per cent and more, it falls between the range of eight or nine per cent and the 30 per cent figure. Verification of this estimate and knowledge of statistical inferences regarding hearing test procedures was needed.

Hearing Testing Methods.

Prior investigators have frequently described the difficulties encountered

in testing the hearing of mentally retarded children. Procedures have been presented in the literature for this specific purpose. Those methods recommended by prior investigators were surveyed to determine possible results and the nature of the test procedures.

Kodman (25) investigated the relationship between administration time for two types of hearing test procedures and the mental ability of retarded children at the Columbus, Ohio State Home. Sixty children aged 7 to 13 were selected for the study (four were untestable). He first used the alternate ear technique and one week later used standard audiometric technique. The techniques used were not counter-balanced (that is some practice effect from the first test procedure might have influenced the results of the standard audiometric technique). Frequencies tested were 250 to 8000 cycles. A loss of 20 db or greater at two frequencies was considered significant. Forty-three per cent of the more intelligent and forty-seven per cent of the less intelligent had hearing losses by the alternate ear method. Thirty per cent of the more intelligent and thirty-three per cent of the less intelligent had hearing losses by the standard audiometric procedure. It appeared as though the standard procedures were better in that they defined less of the group as having hearing loss than the alternate ear method. Kodman subsequently recommended the use of psychogalvanic skin response audiometry for the untestable group and the use of a battery of tests rather than pure tone alone.

Kodman (27) reported on the use of psychogalvanic skin response audiometry with severely mentally retarded children at the Kentucky Training Home in 1959. Twenty-eight children (27 males and 1 female) were tested from an attempted sample of thirty-one subjects. Subjects ranged in chronological age from 7 to 21 years; in IQ from 25 to 64. None of the subjects selected

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were considered to have a serious hearing impairment. The primary aim was to obtain subjects with normal or near-normal hearing for study, although hearing loss was allowed to vary as it appeared in the sample. Speech reception thresholds were also measured in this group over headphones. Standard PCSR testing procedures were followed except that reinforcement was varied from 50 per cent to 100 per cent in order to determine the significance of this variable. Varied reinforcement schedules of 50 to 100 per cent did not produce statistically significant results with respect to the 500 cps test frequency or the 2000 cycle test frequencies used in the study. Latency time did not differ from the 500 or 2000 cycle stimuli. A correlation coefficient of .74 was obtained between the PCSR responses for the 500 cycle tone and the speech thresholds. A correlation of .64 was obtained between the PCSR responses for the 2000 cycle tone and speech thresholds. Since apparently all of the subjects used by Kodman on PCSR were testable by speech audiometry, the time involved (approximately two hours per subject) might indicate PCSR audiometry was not demonstrated to be uniquely useful, i.e., speech reception testing worked and ordinarily would have involved less time. The frequently occurring recommendations in the literature for the use of PCSR on the mentally retarded population defined its value usually as being able to obtain hearing test results when other test procedures were not useful.

Moos, Moos, and Tizard (33) attempted to utilize PCSR audiometry in 1961. They attempted testing of 24 subjects but after compilation and evaluation of their data felt that the test should be abandoned with mentally retarded children.

Hearing Test Procedures with Children.

Procedures useful in testing the hearing of small children might have

some applicability to the mentally retarded population. Typically they involve fewer demands on the subject in the way of responses and are often useful over a wide range of behavior. Accordingly, a search of the literature was made in regard to the recommended procedures for hearing testing of children.

Pure tone. Bloomer (4) devised a method of pure tone audiometry for children between the ages of three and six years. Pictures were found of animals or objects which made a noise corresponding to the frequency of a pure tone. To keep the test short, only four frequencies - 256, 1024, 4096, and 8192 - were used. These were presented to both ears. The child was told that he would hear the bird sing, the train whistle, etc., and instructed to stop the noise when he heard it by touching the appropriate picture. When the noise stopped, he took his finger off. For each different tone, he was allowed to hold the earphone to his ear and heard the particular sound to be tested before it was actually presented.

Keaster (24) suggested the use of a beat frequency oscillation on children with no speech, no response to speech, and with whom it was not possible to do standard audiometric testing. The child was placed in a sound room and the pure tones were fed in. Hearing was indicated if the child responded by looking for the source of the sound, by covering his ears, or by crying.

Many variations of pure tone audiometry have been devised making use of techniques designed to interest and attract children, thereby increasing attention span and making pure tone stimuli more meaningful. Perhaps the most widely known of these is the Dix and Hallpike (12) "Peep-Show". The test was designed to overcome some of the usual problems of giving significance to pure

tones, and of getting cooperation by making the function of listening more simple to understand. The apparatus for the Peep Show included a box with a picture inside that could be illuminated, a viewing hatch in front of which the child was seated so that he could see into the box when it was illuminated, a signal lamp attached to the box within view of the child, a push button, and a loud speaker. The tester stood behind a screen which had a hole for him to look through five feet away from the child. The tester was provided with a pure tone generator and controls for the signal light, the loud speaker, and the light which illuminated the picture. Switches were arranged so that the illuminating light turned on only when the subject and the tester pressed their separate push buttons at the same time. The procedure for administering the Peep Show was as follows: The tester went behind the screen, and the subject was seated in front of the peep hole with the tester's assistant seated beside him. The tester then turned on the 1024 pure tone at 80 db above the normal threshold. The tester turned on the signal light along with the pure tone. The assistant with the child pushed the switch and showed him that the picture inside the peep hole was illuminated. This same procedure was continued until the child learned to push the switch himself when the light and tone appeared simultaneously. At this point, the light signal was withdrawn, and the child continued responding to the tone by itself. Intensity was lowered by 20 db intervals until there was no response; then was raised by 10 db intervals to obtain a threshold. The same procedure was followed for other frequencies in the following order: 1024, 2048, 4096, 8192, 512, and 256. When each new frequency was begun, the peep hole picture was changed and the light signal conditioning was repeated. Total test time was about ten to fifteen minutes. As tones were presented in free field, the

thresholds obtained were binaural. The test was considered to be especially valuable for children of three to five years of age.

A variation of the Peep-Show called the puppet show hearing test has been designed by Waldrop (46). Six puppets of a current T.V. show were used in a theater which was mounted on top of a pure tone audiometer or in the observation window of a two room free field situation. Three lights were mounted above the stage of the theater, and there were two push buttons; one for the subject and one for the tester. The tester presented the tone and the child was conditioned to push the button when he heard the tone. When he pushed the button at the same time as the tester pushed his, the theater was illuminated, and the tester or his assistant presented one of the puppets engaged in some sort of action. By this method of conditioning and reinforcement, an audiometric curve was obtained. The test was recommended especially for children from three to six years of age.

Guilford and Haug (20) presented another audiometric setup for the purpose of testing the hearing of very young children. Their device was called the pediacoumeter, and its advantages were given as follows: The pediacoumeter was portable, inexpensive (about \$125), easily administered, had attention holding appeal, was easily interpreted, was used in conjunction with the audiometer, and did not require special test conditions. The equipment consisted of the audiometer, seven jack-in-the-box heads attached to solenoids in a rectangular box, with a push button to make them jump up. The switches were arranged so that both the testers and the subjects must be closed at the same time for the boxes to open. There was also a red signal light. There were two tests that could be given with this equipment--the conditioning test and the normal test. The normal test was used with children with a maturity

level of three years and above, and where there were no indications of total hearing loss or of mental disturbance. Instructions given to the child were that there were some people in the boxes hollering to get out. When he heard them holler, he was to press the button and let them out. He was told that the headphones were to help him hear the people. The operator found the general hearing range of the child and then varied intensity in 5 db decrements. When he presented the tones, he pushed the switch so that the boxes could be opened. If the child pressed his push button when there was no tone presented, a red light flashed on and the examiner reminded him to listen more carefully. When the idea of the test was fairly well established in the child's mind, two trials were made at each frequency in one ear; then the other ear was tested. The seven audiometric frequencies corresponded with the seven heads in the pediacoumeter. The conditioning test with the same instrument was given with children whose chronological or mental age was so low that it interfered with comprehension of instructions, when there was indication of total deafness, or when too low auditory-perceptual maturation levels prevented ordinary response to pure tones. This test did not produce an audiogram, but merely checked whether the child heard or not, and gave a general idea of degree of impairment. For this test, the red light was turned on, the tone was presented well above threshold, and the switch releasing the boxes was turned on (all at the same time). The process was repeated until the individual being tested realized that a favorable response could be obtained when the light and sound stimuli both appeared. When this was well established, the light stimulus was removed and the tone was presented alone. If the child still responded by pushing the button, it was assumed that he was responding to the auditory stimulus and was hearing. If he did not respond, however, it could not be concluded that

he did not hear, but only that he may not have been properly conditioned. To determine the value of the pediacoumeter hearing test, an experiment was conducted whereby twenty children were tested and retested on the audiometer and on the pediacoumeter. Results showed a 0-10 db difference range on the pediacoumeter with a range over all frequencies of 21-42 db. The audiometer showed a 0-50 db difference range with range over all frequencies of 19.2 - 34.3 db.

Froeschels (17) described a method of pure tone testing whereby a ball was rolled down a chute into the child's playroom after a tone was sounded. The object was to condition the child to reach for the ball every time he heard a tone.

Speech reception tests. Morley (32) described a test designed for nursery age children which used the speech reception circuit of an audiometer. The child to be tested was seated at a small table upon which were placed several familiar pictures. Before placing the headphones on the child, he was instructed to point to the picture which was named by the tester. The headphones were then positioned and the examiner moved out of the child's visual range. With the output attenuated to low intensity, the examiner requested the child to point to the various pictures. As one child was tested, others were permitted to observe the procedure.

A recorded test was devised by Larson as reported by MacFarlane (30). Instructions were given to "Show me your head, show me your mouth, etc." There were nine similar questions read by a male voice requesting the child to point to some part of his body. Intensity was gradually reduced to obtain a threshold.

Keaster (23) designed a test for children three to six years old who had enough hearing to have developed speech understanding. The test was planned

to fulfill the following requirements: (a) appealed to children, (b) required no verbal response by the child, (c) took into account the short attention span of the young child, (d) was short enough to hold the attention of the youngest child in the age group, and (e) used a standardized vocabulary. Words used for the test were selected from the International Kindergarten Word List on the basis of most common usage and phonetic content. For testing, the child was placed in the sound room with an observer. Pictures were put on an easel in front of the child. Before the test, he was asked to name the pictures or identify them to be sure that he recognized the objects. From the control room, the tester then began giving directions such as "Put the rabbit on the floor." The observer demonstrated a few times until the child was sure of the procedure. Intensity was gradually lowered until the child ceased to respond. The threshold score was given as the lowest level at which the child could follow at least three directions correctly. This threshold by inspection appeared to be similar to pure tone threshold scores within the speech range.

Gross sound testing. Myklebust (34), as a means of judging hearing for speech, gave four levels of response for free field testing: (1) ability to hear conversational speech--30 db or less, (2) impaired hearing for conversational speech--30 db to 60 db (these individuals could not acquire speech normally and could have nerve or conductive loss), (3) severe loss of hearing for speech--60 to 100 db (may respond to sounds in speech range, but not to speech unless it was amplified, generally inner ear defect), and (4) no response to speech range--100 db and up.

The Urbantschitsch whistle test consisted of a set of whistles, ranging over a scale of six octaves and giving a compound rather than a pure tone.

The intensity of the whistles could not be accurately determined. It was possible with children two years or older to measure the distance at which they heard the sounds. Older children could be trained to give a motor response when they heard the whistle sounded behind them. Generally, the test was given in the free field and was consequently binaural; however, it could be done by presenting the whistle to each ear separately via an ear tube. Indications of whether or not the child heard the sound included blinking, grimacing, withdrawal, turning toward the source of the sound, head and body wavering, or jerking of eyeballs in the direction away from the source of the sound.

Froeschels (17) pointed out one of the main values of the Urbantschitsch whistle test was that the results were dependent upon reflex so that it could be used without the cooperation of the patient. Froeschels used the Urbantschitsch whistle test with infants and found that 31 out of 33 reacted positively to the whistles.

Beebe (2) suggested using only five to ten tones at one testing, and interpreted the results of the test with the following indications for training: (a) No, few, or weak positive responses--little hope for auditory stimulation; direct to special education for the deaf. (b) More than two or three positive reactions--temporary auditory training and lip reading. (c) Positive response to the majority or all of the whistles, seven if in one ear only--intensive auditory training at once.

Hearing testing which combined several methods. The Swings (14, 15) in attempting to determine the hearing losses of small children used a combination of gross sounds and speech reception testing. In this type of hearing evaluation, toys were made accessible to the child. When he became interested in the toys,

he was asked to do specific things with them, such as pick up a certain one and put it in a box. He was then taught to respond to a visible signal accompanied by sound such as the tester beating a drum. By removing the visual signal, the tester could check how well the child responded to auditory stimuli alone and could change the stimulus to noises made up of other frequencies or to speech commands such as "GO". Children over three years were asked to repeat consonants. Hearing was not considered normal unless they responded to all vowels and consonants at six feet away. Other stimuli used for testing hearing were noise makers measured in respect to frequency and intensity and gradually reduced voice intensity. The Ewings set up standards which could be consulted in determining deafness during the early years.

Gross sound testing apparently could give valuable information as to whether or not a child heard and approximately how much he heard; however, they were not as accurate nor objective as some of the other methods which measured degree and type of hearing loss.

Hearing test procedures with children have attempted test simplification so that fewer demands are made on the child in terms of the response he is expected to make to sound. They have frequently employed conditioning, curiosity, and attractive or unique stimuli to facilitate responses from the child as well as to aid in their interpretation. Investigation of the utility of these approaches with mentally retarded institutionalized patients was needed.

Electroencephalic Response Audiometry (EER-Audio).

The use of electroencephalography for the detection of responses to auditory stimulation dates back to the late 1940's when Doerfler (13) and

Marcus, et al. (31) reported the successful use of such techniques. Although the clinical implications of such a procedure were recognized, little further research in this area was reported until approximately five years later when Perl, et al. (35) found a reasonably high correlation between thresholds obtained by speech testing and EEG recording in sleep for a group of subjects with varying degrees of hearing loss. Derbyshire, et al. (7), during this same period, also reported the successful identification of EEG responses (K formations) to auditory stimulation while the subjects were in a light stage of sleep. They were able by this means to establish thresholds for 22 subjects which agreed with those obtained by standard audiometry within a plus or minus 18 db.

Winthrow and Goldstein (48), in 1958, reported that they were able to estimate within a plus or minus 10 db the thresholds of a group of children at the Central Institute for the Deaf. The term Electroencephalic Response Audiometry (EER-Audio) was suggested about this time by Goldstein and Derbyshire (19) to describe the "tests for hearing which utilize electroencephalic responses as indicators of reaction of the ear and central nervous system to sound."

A number of articles also appeared at this time which set forth methods for the administration and evaluation of EER-Audios. Derbyshire and Farley (9) suggested the use of randomly presented stimuli (pure tones), interspersed with no-stimulus or control periods. Reading directly from the tracing, possible responses were given weighted scores representing the degree of change in pattern at the onset, throughout and at the termination of the stimulus presentation. Similar judgments were made for the control periods. These scores were then subjected to statistical analysis to determine whether

tones of a given frequency and intensity elicit more changes than occur in the control periods. Rosenblut, et al. (38) suggested a similar method of evaluation requiring only a simple "yes" or "no" choice in the identification of responses. Winthrow, et al. (48) extended this technique to the development of a table of "Criterion for Estimation of Threshold." It consisted of two columns; one representing the false-positive responses which might be detected in the control periods and the other the number of responses to stimuli to be significantly greater than the false-positives. This permitted and facilitated rapid scoring.

A different approach to evaluation was used by Abe (1) and Suzuki (44). This involved the photographic superimposition of traces as originally suggested by Dawson (6). A number of records, similarly recorded, are superimposed on a single sheet of paper and if the deflection is evoked with regular latency, it is thus emphasized and distinguishable from the background waves. Utilizing this approach Suzuki reported that with repeated tests on 10 subjects that the resultant audiograms showed a 20 db or less discrepancy, in more than 80 per cent of the instances examined, against those taken by standard subjective methods.

In the past few years extensive interest has been displayed in the use of computer techniques for the detection of EER-Audio responses. Lowell (29), Williams (47), and Derbyshire (8) have made considerable use of such techniques in the investigation of factors such as the latency and per cent of positive responses as functions of intensity. Lowell used a specially constructed analog computer to "average out" responses to electronically produced clicks. The authors hypothesized that since responses are temporally related to the stimulus presentations, they could be revealed by averaging sufficient random

samplings at fixed intervals following the stimuli presentations. They administered and averaged responses to over 1,000 stimulations at each of three stimuli repetition rates and at three intensities. Their results indicated definite positive peaks were evoked 35 msec. following stimulation. The spontaneous or no-stimulus periods were averaged to zero. Williams used both manual measurement and computer analysis to detect cortical changes in children in a waking state. His results indicated that such changes were identifiable by both types of measurement and the monopolar recordings gave more reliable results than did bipolar recordings. He found the mean latency of responses to be about 157 msec.

It seemed apparent from the reported research that EER-Audio could provide a clinically useful standardized procedure to obtain at least a gross estimate of auditory function (9,38,48). Although it has not been possible to validate the results of such procedures with the results of standard audiometry, the relationship between acoustic stimulation and changes in brain wave patterns has been well established. Identifiable characteristics of these response-changes, such as latency, amplitude, diffuseness, and relationship to intensity have been well defined (7, 29, 35, 47). Consequently, it may be that such validation is unnecessary and impractical. Derbyshire (7) states:

"If we chose agreement with a conventional audiogram as our criterion for adequacy, there would be no reason for the innovation of a new method . . . the two tests tap different points in the auditory process."

Thus, it appeared that these procedures could best be utilized as adjuncts to existing audiometric procedures and were in need of further study to extend their scope. In this respect it was interesting to note that little if any work has been done in the past to determine the suitability or success of

this kind of objective audiometric testing with a mentally retarded population. It appeared evident, from the difficulties reported in testing this population with standard procedures, that there was an apparent need in this area.

SECTION II
PRELIMINARY HEARING TEST
STANDARDIZATION AND EVALUATION

TEST STANDARDIZATION

Problem.

It was recognized that the multifarious variations of audiometric techniques suggested in the literature could not be subjected to evaluation due to time limitations. Since many such variations involved only minor modifications or adaptations of equipment or procedures this was not considered to be a deterring factor. A total of 21 different test procedures were collected which included pure tone air and bone tests, speech reception tests, sound localization tests, electrodermal response tests (EDR)* and EER-Audio. It was found upon examination that many of these procedures, thought to be clinically useful with normal populations, with selected populations of retardates could not be adopted in toto. The variety of mental, physical, and behavioral capacities that were to be found within an institutional population necessitated a number of eliminations, refinements, and adaptations. As a result of the preliminary examinations, literature exploration, and consultant staff meetings the number of tests to be evaluated was reduced to 12. The problem in test standardization then appeared to be that of making appropriate modifications in the test procedures for this population and to delineate the specific characteristics of those procedures precisely enough to permit replication.

Method.

Subjects. Preliminary testing directed toward procedural standardization was undertaken with a representative group of 32 patients selected from the total population, with a mean age of 9.34 years (S.D. 4.02 years).

*EDR is used subsequently in this report to refer to psychogalvanic skin response audiometry (electro-dermal response) as suggested by Goldstein and Derbyshire.(19).

Equipment. The equipment necessary for the administration of the tests to be standardized and evaluated was purchased and installed in a building centrally located on the grounds of the institution. The following items were included. An 8' x 10' x 8' sound field room was constructed to provide an adequate environment for screening at an intensity level of 20 db. A high fidelity speaker was located in each of the four corners and a wall mounted microphone was installed for intercommunication purposes. Terminal boxes for EDR and EER-Audio, plugs for earphones, a bone conduction oscillator, and two electrical outlets, one of which could be remotely controlled, were built into the walls. The room was provided with a door, large enough to permit the entrance of a hospital bed or crib, and an adjacent observation window. Located outside of the room beneath the window, was an L-shaped counter on which was mounted the testing equipment and a control panel. The testing equipment consisted of a Beltone, Model 15C, audiometer and an Apex stereo tape recorder, Model 932. The output of each of these devices was wired into the circuitry of the control panel. The audiometer was also wired directly into the earphone and bone conductor plugs inside the sound room. The control panel contained a 50 watt Crompton amplifier and two Daven attenuators, calibrated in 1 and 10 db steps. All stimuli could be amplified, attenuated, and switched directly to any of the speakers, the earphones, or the bone conductor from this panel. The addition of a microphone to the panel provided a speech circuit. A Grason-Stadler psychogalvanometer was mounted on a table near the equipment counter and adjacent to the audiometer.

Two motivational devices were acquired for use in pure tone testing. One was a modification of the Peep Show apparatus as reported by Dix and Hallpike (12). This device consisted of an automated slide projector which was adapted

so that the circuit to the projector bulb was interrupted with two switches, wired in series. One was a large, easily manipulated switch attached to the device and the other consisted of the remotely controlled electrical outlet on the sound room wall into which the power cord of the device was plugged. A second device was constructed and referred to as the "Powell Motivator".* This consisted of a box with a relay operated, clear plastic door under which candy could be dispensed. A General Radio, Octave Band Noise Analyser, Model 1550-A, was used to filter pre-recorded sounds for some of the test procedures.

Procedure. Appropriate adaptations and modifications of hearing test procedures described in the literature were made in this experiment. This was done by utilizing clinical judgment as to which test a given patient might respond to, making appropriate refinements to accommodate mental and physical handicaps and thus obtain as accurately as possible a measure of the patient's hearing and setting down a detailed description of the resultant procedures. Scoring forms for these tests were also developed as part of this experiment and are presented in Appendix A.

Results.

The following test descriptions represent the results of the standardization procedures described above. These tests were evaluated in subsequent research.

Play Audiometry - Air. This test employed a color cone which consisted of a wooden dowel secured to a small plywood base and a dozen plastic, colored blocks shaped as squares, rectangles, and circles with center holes slightly larger than the diameter of the dowel.

*Developed and constructed by E. Powell, Instructor, Central Michigan University.

The patient was seated in the sound room and the dowels and blocks were placed before him. An earphone was held to his right ear by the evaluator and he was then instructed to place a block on the dowel whenever he heard a tone. A test tone of 1000 cps was presented to the right ear at an intensity of 60 db and the patient was guided through the required response procedure. Three guided trials were carried out for each ear. During the seventh presentation of the tone the patient was not assisted. If he did not respond, the evaluator then repeated the instructions and the intensity of the tone was raised by 20 db. Failing to obtain a response at this new intensity level, the above procedures were then repeated until the patient responded appropriately or the maximum intensity level of the audiometer was reached (100 db). All tones were of 10 second duration and the blocks were removed or replaced on the dowel, depending upon whichever appeared to be most easily accomplished by the patient.

If a response was secured, the test was administered by the following accepted principles of pure tone audiometry. The lowest intensity at which a patient responded correctly at least 50 per cent of the time was considered his threshold. For reasons of expediency, only the frequencies 500 and 2000 cps were tested in each ear. Since this test was designed as a screening device, a response at 20 db at each frequency tested was considered as normal hearing and no thresholds below this intensity were obtained. However, if a patient showed a loss greater than 20 db in one or both frequencies in either ear, pure tone thresholds for the frequencies 250, 500, 1000, 2000, and 4000 cps were to be attempted at a later date.

Play Audiometry - Bone. A bone conduction oscillator was placed on the patient's mastoid process and the procedure described above (Play Audiometry -

Air) was employed for bone conduction testing. To keep demands upon the patient at a minimum, no masking was employed.

Candy Motivational - Air. This test employed the "Powell Motivator" described previously. The patient was seated in the sound room facing the motivator. An earphone was held to his right ear by the evaluator and he was instructed to push open the door and remove a piece of candy whenever he heard a tone. A test tone of 1000 cps was presented to the right ear at an intensity of 60 db and the door was unlocked while the tone was on. The patient was then expected to remove a piece of candy from the box to indicate that he heard the tone. If he did not respond, the evaluator demonstrated the desired response while the tone was repeated at the same intensity. The evaluator then repeated the directions and the intensity of the tone was raised by 20 db. Failing to obtain a response at this intensity level, the above procedures were repeated until the patient responded appropriately or the maximum intensity of the audiometer was reached (100 db). All tones were of 10 second duration and the motivator door was unlocked only during this period.

If a response was secured, the test was administered by following accepted principles of pure tone audiometry. The lowest intensity at which the patient responded correctly at least 50 per cent of the time was considered his threshold. Since it was felt that the motivational value of candy would decline with successive administrations, only the frequencies 500 and 2000 cps were presented in each ear. This test was designed as a screening device, so a response at 20 db at each frequency tested was considered as normal hearing and no attempt to obtain a threshold was made.

Picture Motivational - Air. This test utilized a modified "Peep Show" device. The apparatus was so constructed that each activation of a patient

switch, in conjunction with the tester's switch, illuminated a projector and produced a different picture.

The patient was seated in the sound room an appropriate distance from the motivational device. An earphone was held by the evaluator to the patient's right ear and he was instructed to push a button to see a picture whenever he heard a tone. A test tone of 1000 cps was presented to the right ear at an intensity of 40 db. The patient was then expected to push the button to indicate that he heard the tone. If he did not respond, the evaluator demonstrated the desired response while the tone was repeated at the same intensity. The evaluator then repeated the directions and the intensity of the tone was raised by 20 db. Failing to obtain a response at this new intensity level, the above procedures were repeated until the patient responded appropriately or the maximum intensity of the audiometer was reached (100 db).

If a response was secured, the test was administered by following accepted principles of pure tone audiometry. The lowest intensity at which the patient responded correctly at least 50 per cent of the time was considered his threshold.

Since it was felt that the motivational value of the pictures declined with successive administrations, only the frequencies 500 and 1000 cps were presented in each ear. This test was devised as a screening device, so a response at 20 db was considered as normal hearing and no attempt to obtain a threshold was made.

Picture Identification - Free Field. This test utilized a series of 27 colored pictures (the picture selection procedure and list of pictures is given in Appendix B) portraying single objects, individually mounted on

an 8" x 10" piece of heavy cardboard. A rack, adjustable in height, on which six cards could be hung was employed to display the pictures. Prior to testing it was determined which pictures could be identified by the patient and any unfamiliar to him were eliminated. The patient was then seated in the sound room at an appropriate distance from a loudspeaker. The tester at the control panel used the speech audiometer, with live voice, to explore for the approximate threshold while explaining the test procedure.

The chart below shows a portion of the test form which was employed:

	1	2	3	Total Correct
+10	_____	_____	_____	_____
+ 5	_____	_____	_____	_____
0	_____	_____	_____	_____
- 5	_____	_____	_____	_____
-10	_____	_____	_____	_____

After the estimated threshold had been established, or an arbitrary one had been selected, it was recorded on the zero line of the "panel setting" column. Intensities 5 and 10 db above and below the estimated threshold were then recorded on the appropriate lines of this column.

The administration of the test, using live voice, was then carried out by the random selection, and presentation of six pictures. The tester commencing 10 db above the estimated threshold asked the patient, using the phrases "point to" or "show me", to identify one of the pictures. Each successive request was attenuated 5 db. The patient's threshold was established as the lowest intensity to which he responded correctly two or more times.

After five presentations a new set of six pictures was displayed. If the

patient was able to respond correctly to the fifth picture in a series, the results were eliminated and new "panel setting" intensity levels were established. The "old" -10 db level was used as the "new" +10 db level and the test was continued until the two "lowest" intensities were established.

Commands - Free Field. In this test the patient responded by obeying simple commands which involved locating his body parts. All commands were preceded by the carrier phrase, "Point to your _____." Other phrases were used when this was not effective.

The patient was seated in the sound room at an appropriate distance from a loudspeaker and the evaluator sat beside the patient and acquainted him with the testing procedures. The tester at the control panel then used the speech audiometer with live voice to explore for the approximate threshold using the following practice commands: "Point to your _____ (foot, chin, teeth, knee, or cheek)."

The chart below shows a portion of the test form which was employed:

<u>Panel Setting</u>	<u>Group I</u>	<u>Group II</u>	<u>Group III</u>	<u>Group IV</u>	<u>Total Correct</u>
+10 _____	<u>Leg</u>	<u>Eyes</u>	<u>Arm</u>	<u>Hair</u>	_____
+ 5 _____	<u>Neck</u>	<u>Neck</u>	<u>Hair</u>	<u>Nose</u>	_____
0 _____	<u>Mouth</u>	<u>Nose</u>	<u>Arm</u>	<u>Leg</u>	_____
- 5 _____	<u>Shoe</u>	<u>Hand</u>	<u>Ear</u>	<u>Nose</u>	_____
-10 _____	<u>Hand</u>	<u>Hair</u>	<u>Nose</u>	<u>Neck</u>	_____

After the estimated threshold had been established, it was recorded on the zero line of the "panel setting" column. Intensities 5 and 10 db above and below the estimated threshold were then recorded on the appropriate lines of this column.

The administration of the test, using live voice, then proceeded with the presentation of the items in Group I at the indicated intensities commencing 10 db above the estimated threshold. Thus, each successive item was attenuated 3 db. The same procedure was followed with groups II and III. The patient's threshold was the lowest intensity to which he responded correctly two or more times.

Group IV was included in the event that the patient was unable to respond at all five intensities during the presentation of Group I. If at the last command in Group I the patient was able to respond correctly, the results could be eliminated and new "panel setting" intensity levels were established. The "old" -10 db level was used as the "new" +10 db level and the test was continued using Groups II, III, and IV.

Free Field live Voice Awareness. The patient was seated in the sound room at a point approximately equally distant from the four corner speakers. He received no instructions prior to testing. The evaluator was seated in the sound room with the patient to maintain his interest in the test and to record responses. He was also responsible for positioning the patient in the center of the room before each stimulus presentation. Prior to the administration of the test an attempt was made to determine which live voice sounds, e.g. whistles, greetings, etc. would best attract the patient's attention. The tester at the control panel administered the stimuli by means of a microphone, using the four corner speakers alternately in a random order. Unlike the preceding tests in the battery which require a specific motor response, in this test any indication of an awareness of the stimulus was accepted, e.g. cessation of activity, eye movements, etc.

The test began with live voice presentations at 60 db and continued at

this level until one of the two following criteria were met: (1) responses to two out of four presentations (+), or (2) four consecutive no-responses (0). Throughout the test the intensity was increased in 10 db steps and attenuated in 20 db steps. Thus if a "response" (+) was obtained at the 60 db level, the intensity was lowered to 40 db. If a "no-response" (0) was obtained at the 60 db level, the intensity was increased to 70 db. This procedure (raising intensity 10 db when a (0) was obtained and attenuating 20 db when a (+) was obtained) was continued until a previously tested intensity level was reached. The patient's threshold was assumed to be the lowest intensity at which two responses (+) were obtained.

Free Field Taped Sounds. This test utilized a tape recording which contained six repetitions of eight different sounds. These 48 sounds were each of three second duration and occurred in random order on the tape.

The sounds were administered in the order in which they occurred on the tape so no attempt was made to determine their effectiveness prior to testing.

With this exception, the procedure described above (Live Voice) was employed in the administration of this test.

Free Field Taped - Filtered White Noise. This test utilized a tape recording which contained twelve repetitions of four different filtered white noise sounds. Each of these four sounds consisted of one of the following octave bands: 300-600, 600-1200, 1200-2400, and 2400-4800 cps. These 48 sounds were each of three second duration and occurred in random order on the tape.

The administration of this test followed the procedures outlined above (Taped Sounds).

HR Pure Tone - Shock. This test employed a Grason-Stadler

psychogalvanometer. The following settings were used in conditioning the subject to the tone and shock:

1. Stimulus time 1.5 seconds
2. Delayed time 1.5 seconds
3. Conditioning time .6 seconds
4. Conditioning level from .25 to 2.5 millamps

The patient was seated in a chair in the sound room. The evaluator positioned the electrodes on the patient's feet or legs and remained in the room throughout the test. The tester operated the GSR equipment from the control panel outside the room. After the subject's general level of skin resistance was established, the intensity of the shock level was regulated until a good excursion of the writing stylus was obtained.

Conditioning consisted of the presentation of three or more combinations of tone (1000 cps at 60 db in the right ear) and shock. A minimum of 12 tones with and without accompanying shock were presented and interspersed among the stimulus-condition pattern until responses to tone were secured without shock. When the patient appeared conditioned to the tone and shock, a tone in the right ear at 1000 cps and 60 db intensity was presented. This tone was administered several times and two definite responses were established as the criterion for hearing at this intensity. If the patient did not respond, the intensity was increased in 20 db steps. If a response was obtained, the intensity of the tone was reduced in 20 db decrements until no response was obtained, then the tester used 10 and 15 db shifts to obtain threshold measurements. Responses at 10 db were considered "normal hearing" and no lower intensities were tested. These same procedures were employed for testing at 4000 cps and in the administration of these two frequencies to the left ear.

EDR Voice - No Shock. A Grason-Stadler psychogalvanometer was used in the administration of this test. However, no shock was employed. The tester administered emotionally laden phrases by means of live voice - free field through a speech audiometer. The phrases were initiated at 60 db and if the patient did not respond at this level, the intensity was increased by 20 db. After two definite responses were obtained, the intensity was attenuated in 20 db steps until the patient's threshold or an intensity level of 20 db was reached. The criterion for threshold was the same as that described in EDR - Shock.

EDR Noise - No Shock. The procedures for this test were the same as those described above (Voice - No Shock). However, instead of live voice this test utilized a tape recording which contained six repetitions of eight different sounds. These 48 sounds were each of three second duration and occurred in random order on the tape.

TEST EVALUATION

Problem.

In accordance with the stated objectives of this study, an evaluation of the 12 selected audiometric techniques was undertaken to determine which of these might be effectively used to screen the hearing of the entire population of an institution for the mentally retarded.

Method.

Subjects. Three groups of 20 subjects each were randomly selected from the total number of patients, under the age of 10, available in the institution and consequently were considered to be representative of that group. These patients were selected since it was anticipated that this age range would be the most difficult, and at the same time, the most important

age range to evaluate adequately. The mean age for the total groups was 5.9 years.

Equipment. Equipment used for each test was identical to that described in the preceding Test Standardization section.

Procedure. The 12 tests to be evaluated were divided into three test batteries. Each battery was administered to a different, randomly selected group of subjects to minimize variables such as practice effect. The order of presentation of the individual tests was randomized for each subject within the groups to avoid any systematic bias due to the order of the tests.

Hearing Test Battery I compared the relative effectiveness of the following four pure tone procedures: (1) a play technique utilizing a color cone and administered by air conduction, (2) an identical procedure administered by bone conduction, (3) a motivational technique employing a candy dispenser, and (4) a motivational technique employing a modified Peep Show. All of the tests in this battery involved the use of either earphones or a bone conduction oscillator.

Test Battery II compared the relative effectiveness of five free field hearing test procedures: (1) a modified picture identification test, (2) a speech reception test utilizing simple commands, (3) a sound localization test employing live voice sounds, (4) a sound localization test employing unique and unusual sounds filtered into specific octave bands, and (5) a sound localization test employing white noise filtered into specific octave bands.

Test Battery III compared the relative effectiveness of three electrodermal techniques: (1) a standard conditioning procedure involving pure tones coupled with shock, (2) the presentation of emotionally laden words without

accompanying shock, and (3) the presentation of unique and unusual noises without accompanying shock.

Results and Conclusions.

Results are presented below for each test battery.

Hearing Test Battery I. The data obtained indicated that only one child was adequately tested with any of the tests in Battery I. A threshold of 20 db was obtained for this patient and he was testable on all of the procedures used. These results were interpreted as corroborative evidence to prior research indicating a high proportion of young mentally retarded institutionalized children were untestable with pure tone test procedures. It was interesting to note that no procedure in this battery, regardless of its motivational value with "normal" children, appeared superior to any other procedure in the battery when administered to mentally retarded children. Major problems observed were the lack of acceptance of headphones and bone conduction oscillators and the difficulty in making the necessary associations between the initiation of pure tone and the presence of the motivating stimulus. Repeated trials did not appear to be effective, perhaps because of the complexity of the necessary associations.

Hearing Test Battery II. Results of Test Battery II, with the exception of the Speech Reception Tests, indicated generally that these procedures were more successful in obtaining thresholds of 20 db or less than those in Battery I. Table 1 gives the frequency of patients having thresholds of 20 db or less in each of the five tests of the battery (Picture Identification, Commands, Taped Sounds, Live Voice, and White Noise). In view of the small number of patients obtaining thresholds of 20 db or less (two patients) in the Speech Reception Tests, these tests were not included in the analysis of frequencies.

Table 1
(Frequency of Thresholds by dB Level)
Test Battery II

Test	dB Level						
	10	20	40	50	60	70	80
Picture Identification	1	0	0	0	0	0	0
Commands	1	0	0	0	0	0	0
Taped Sounds	7	2	0	0	1	1	0
Live Voice	12	3	1	0	3	0	0
White Noise	3	4	3	1	4	1	1

Number of Failures

In order to determine whether the remaining three tests differed significantly in obtaining thresholds of 20 db or less, the data were entered into a Cochran Q Test analysis (Siegel (41), 1956) a non-parametric technique.

Results revealed that the three tests did differ at the .01 level of significance. Further analysis indicated that Taped Sounds did not differ from Live Voice or White Noise, but that the frequency of patients with thresholds of 20 db or less in the Live Voice Test was significantly greater (.05 level of significance) than the frequency of the White Noise test.

Hearing Test Battery III. Results of testing with Hearing Test Battery III appeared to be completely negative. No child in the group of 20 attempted was testable by the procedures used. Problems encountered included hyperactivity, failure to condition, failure to accept earphones for conventional pure tone stimuli, failure to accept or tolerate electrodes, difficulty in establishing criterion levels for acceptable responses, and rapid adaptation to shock. Although prior research by others had indicated these results would be forthcoming with this population, comparative data to other test procedures used was of value.

Essentially, the foregoing three pilot studies indicated that in the age group below 10 in the institution, successful screening could best be accomplished with the largest numbers of patients by means of the free field live voice test. It was also apparent that there was no pure tone procedure definitely superior to any other in the group tested. It was hypothesized that this was in part due to the difficulty encountered by many of the patients in making the necessary associations between stimulus and response rather than to any motivational properties of the tests involved. Consequently, any patient testable by any one procedure was likely to be testable by all

procedures. The total failure of the EIM-Audio procedures seemed to be most highly related to inappropriateness of the equipment for these patients. Hyperactivity on the part of any patient made it impossible to establish the general level of skin resistance or to identify a response to auditory stimulation from the concomitant high level of background noise.

CHAPTER III

CLIMATE, GEOGRAPHY AND

PSYCHOLOGICAL - SOCIAL - PHYSIOLOGICAL FACTORS

STANDARD PURE TONE TESTING

Problem.

In pursuit of one of the major objectives of this study, an attempt was made to evaluate the effectiveness of the standard, hand-raising, pure tone technique with the total available population.

Method.

Equipment. All tests were administered by means of a Beltone Model 10-C portable audiometer.

Procedure. The tests were conducted within the patient cottages in available isolated areas. These areas were selected on the basis of a maximum ambient noise level which was not in excess of 40 db when measured on the "C" scale of a General Radio Sound Pressure Level Meter Type 1551-A.

Testing was initiated in the cottages which housed the male "working group" of the institution. This group is composed of patients who are employed at menial tasks on the institution grounds or within the community. These patients represent an elite intellectual group relative to the population as a whole and consequently all were able to respond to the technique employed. However, it was apparent, after a preliminary trial, that considerably less success would be experienced in other cottages. Consequently, a pure tone "indicator test" was devised to expedite the procedure and differentiate between those patients who were testable and those who were untestable by this technique. The procedure involved in administering the "indicator" took approximately three to five minutes and involved asking a patient to raise his hand or give some other acceptable indication whenever he heard the tone produced by a 1000 cps tuning fork which was set into vibration

behind his back and then held close to his ear from behind.

Results and Conclusions.

A preliminary evaluation was undertaken to determine the effectiveness of the pure tone "indicator" test. Two hundred and ten subjects were randomly selected and administered first the "indicator" followed by a standard pure tone test. One hundred and ten of these subjects responded to the "indicator" and of these, 78 were testable by standard pure tone testing. Of the 100 who failed the pure tone "indicator", only seven subsequently were testable by standard pure tone testing.

Chi square was the statistical procedure utilized to treat the hypothesis that the responses to the pure tone "indicator" would be positively related to the ability to be tested by a standard pure tone method. This procedure yielded a χ^2 value of 82.97 which proved to be significant above the .001 level of confidence. On the basis of these results the indicator was used to screen out those patients who would be unlikely to be testable by a standard pure tone procedure.

Table 2 gives a breakdown in age groups of the results of the testing which was carried out by means of the standard pure tone technique. A retest category is presented and represents patients whose initial test results were questionable but who gave some indication of "testability" and who were later retested. It was apparent from these test results that patients who were found to have hearing loss on the first test were, without exception, found to have hearing loss on the retest. The four categories listed represent the following parameters:

H.H.L. - No hearing loss. Patients were assigned to this category who exhibited a 20 db threshold in both ears, for all frequencies tested, with,

Table 2

Results of Post-Trauma Scoring by Age Group

(Age)	0-5	6-10	11-15	16-20	21-25	26-30	31-40	41-50	51-60	Over 60	Percent of Total Available
No Scoring Loss	3	6	26	36	41	36	36	36	6	270	23
Mild Scoring Loss			2	6	7	10	10	8	2	53	6
Severe Scoring Loss		2	2	1		7	16	9		36	3
Unscorable	0.2	100	132	166	102	89	36	20	10	600	70
Percent of Available Patients Testable	0	2	3	17	20	23	36	86	16	66	30
Percent of Testable Patients with No Scoring Loss	100	100	73	80	87	83	76	89	60	73	73
Available Patients											
Retested		1	6	6	6	6	6	16	6	6	35
No Scoring Loss				1	1	3	1	2			7
Mild Scoring Loss			2	6	3	3	6	9	3	2	23
Severe Scoring Loss		1	2	1			1	3	3		15

however, a dip below this level in one frequency in one or both ears accepted.

M.H.L. - Mild Hearing Loss. This category consisted of those patients who exhibited greater than 20 db thresholds for two or more frequencies in either or both ears.

S.H.L. - Severe hearing loss. Patients were assigned to this category whose better ear average was 25 db or greater for the frequencies 500 through 4000.

Untestable - This category included patients who could not make the necessary responses or whose test results contained untenable inconsistencies.

Inspection of Table 2 indicates that 30 per cent of the total available population were testable by standard pure tone techniques. In addition, 75 per cent of those tested were classified as having normal hearing within the limits of the established criterion. It is interesting to note that the 25 per cent reported losses seemed about equally divided between mild and severe types. This is in contrast to the figures reported by other investigators but which may be due in part to differences in the classification criteria employed.

It was previously stated that testing was commenced in the two cottages which housed the male "working groups". It was found that all 181 of these patients were testable and that the percentage of hearing loss was 25 per cent which coincides exactly with that found for the total available population. This is understandable when it is noted that the median age for the working groups is 45 years which was the age at which the highest percentage of patients were testable from the total of those available for testing. It also seems reasonable to assume that the rather high percentage of losses detected may in some part be related to the fact that a great many of the patients testable

by this procedure were past middle age (mean age 43 years) so that on a physiological basis more losses might be expected.

It seems apparent from the results of this and other studies reported in the literature, that standard pure tone procedures have limited utility as audiometric techniques when used to assess the hearing of extended populations. Since it is applicable to some parts of such populations and since it yields considerable information not always available from other procedures, it undoubtedly should be utilized when applicable. Thus, the importance of an "indicator test" is apparent. Locating the patients who are testable by standard pure tone procedures can be done rapidly and accurately.

FREE FIELD, LIVE VOICE, SOUND AWARENESS TESTING

Purpose.

To accomplish one of the major purposes of this study, hearing screening of the total available population was initiated. The free field, live voice sound awareness test was utilized since it had previously given evidence of being the most effective technique of those evaluated.

Method.

Subjects. This test was administered to 1083 patients. Only those patients whose medical histories indicated that the transportation involved in testing might prove deleterious to their health were excluded (161 patients). All such decisions were made by members of the medical staff of the institution.

Equipment. The equipment previously described for the free field, live voice test was employed in this survey.

Procedures. The test was administered following the standardized procedures for the free field, live voice sound awareness test described in Section II.

Results and Conclusions.

As a result of the survey, subjects were placed in four major categories listed and described below:

Passed - Those patients who gave two acceptable responses at the 20 db level.

S.O.P. - Those patients who gave indications of a hearing loss such as responses at higher levels of intensity but not at lower levels; relatively good responses in other sensory modalities; the absence of behavioral patterns or physical handicaps which might interfere with attending to auditory stimuli. They were thus referred for social workups, otological examinations, and psychological testing.

F - Those patients who failed the screening test and who presented behavioral patterns or physical abnormalities which made an evaluation by the standardized sound localization technique impractical or impossible. Further testing by more extensive procedures was recommended.

E - Those patients with behavior patterns which interfered with testing but which appeared to be transient in nature. Retesting with sound localization techniques at another time was recommended.

To facilitate the planning and the direction of further testing procedures the patients who were placed in the F category were further sub-classified into seven groups which were thought to be generally representative of the type of behavior which negated the initial tests. These groups were:

(1) - Indications of Hearing Loss

(2) - Psycho-motor behavior. Includes behavior such as head-pounding, hand-wringing, etc.

- (3) - Withdrawal. Autistic behavior, etc.
- (4) - Secondary physical handicaps. Blindness, loss of limbs, etc.
- (5) - Hyperactivity. Pacing, head shaking, etc.
- (6) - Vocal Masking. Moaning, screaming, shouting, etc.
- (7) - No complicating secondary factors, but do not respond.

Table 3 gives a breakdown of the results of the total screening procedures by age groups. Table 4 provides a percentage breakdown, by age groups, of patients passing the FFLV test.

Inspection of Table 4 indicates that 76 per cent of the total population tested were passed at the 20 db intensity level. In addition, the lowest percentage of patients passing the test fell in the 0-5 year age bracket. It is interesting to note that this is similar to the results reported for the normal population in that children below the age of five have traditionally been difficult to successfully evaluate with standard audiometric procedures (19, 23, 42). However, the total percentage of patients passing the tests is definitely below that which might be expected from a similar test with normals.

In order to establish a test-retest reliability coefficient, 50 subjects were randomly selected and retested using the same testing procedure. A Pearson product moment correlation of .546 was obtained. This was of a magnitude to indicate a significant relationship between subjects' results from one administration of the test to another.

In view of the fact that 834 patients were passed by the FFLV procedure, it seems apparent that this technique provided much more utility as a screening device than any of the standard audiometric procedures previously evaluated with a mentally retarded population. It was recognized that this test provided

Table 3

[illegible]

Table 4

Frequency and Percentage of Patients, by Age, Passing FFLV Test

Age Group	F	% Passed
0 - 5	73	45
6 - 10	162	61
11 - 15	110	71
16 - 20	139	85
21 - 25	136	76
26 - 30	132	81
31 - 40	127	86
41 - 50	126	93
51 - 60	72	82
61 and over	16	69
TOTAL	1093	76

Total population available = 1234 (11% excluded for medical reasons)

only a gross assessment of hearing status and did not detect high frequency or unilateral losses. However, it did give some indication of the kinds of procedures which should be pursued in the development of more refined techniques.

SOCIAL WORK EVALUATION

Problem.

It appeared of potential interest to investigate the case histories of the children suspected of hearing loss as a result of the free field live voice procedure. This group of subjects was broken into two categories following the FFLV test. Category 1 was utilized where a "real" hearing loss was suspected (N=55). In this case, the child was referred to social work, otology, and psychology for further analysis of the problem. Priority orders, starting with the youngest, were established for those subjects under age 20 on the understanding that identification of social, otological, and psychological characteristics of patients beyond this point would be of less value than of subjects below this age. The second category was based upon the need for further testing (N=200). Category two was further divided into seven subgroups according to whether psycho-motor behavior, withdrawal, secondary physical handicap, hyperactivity, vocal masking, indication of hearing loss, or no complicating secondary factors was observed. Patients in the withdrawn, hyperactive, indication of hearing loss, and no complicating secondary factors groups were also referred for evaluation by the otologist, psychologist, and social worker. A similar order of preference was established for these groups. Analysis of the histories of subjects referred to the social worker was the major purpose of this section.

Method.

Subjects. The total number of subjects given a developmental history analysis by the social worker was 93, with a mean age of 19.53 years. A breakdown of the patients seen according to age levels is presented in Table 5. It should be kept in mind that patients age 20 and below were seen without selection by the social worker, psychologist, and otologist. Patients over 20 were randomly selected from those identified as having suspected hearing loss so that an identification of the nature and extent of the problem at the later age levels could also be estimated. Table 5 also includes the length of institutionalization for these subjects. It can be noted that 40 subjects had been in the institution five years or less. This, of course, reflects the fact that primarily younger children were seen for this analysis.

Procedure. A social work evaluation instrument (Appendix C) was constructed utilizing suggestions in the literature, by the social work consultant, and by the child psychiatry consultant. This social work evaluation instrument was pre-tested on the same 32 subjects (randomly selected) first used to develop and standardize hearing test procedures.

Results and Conclusions.

In some cases where necessary information was missing from the institutional records, contact with the parents or other sources was made to obtain more adequate information. Appendix D presents an item by item breakdown of the results found on the social work evaluation instrument. This data indicated 60 males and 33 females were seen. The vast majority (51) of the patients seen were recognized as mentally defective because of association with diseases or conditions due to unknown prenatal influence. Forty-seven of these subjects, however, did not have abnormal conditions of the mother

Table 5

Number of Patients, By Age and Length of Institutionalization, Seen
For Social Work Evaluation

Years	Number of Patients Seen, by Age Groupings, for Social Work Evaluation	Number of Patients Institutionalized For Each 5 year Interval Indicated
0-5	16	40
6-10	25	19
11-15	13	10
16-20	7	5
21-25	6	6
26-30	4	4
31-40	8	4
41-50	6	4
51-60	6	1
61+	2	0

reported during pregnancy. The majority of the mothers (64) were age 30 or below and 44 of the fathers were age 30 and below. Only 12 of the children were reported to be under a five pound birth weight; although 15 were reported as being premature. Births were reported as cephalic in 62 cases with 27 having no information available. Forty-six of the medical records indicated no abnormalities of labor and 39 did not have abnormalities recorded. With 27 of the subjects, no abnormal condition of the child at birth or neonatal state was recognized; ten were thought to be cyanotic, as well as two anoxic. At birth or in the neonatal stage, 13 were observed to have Mongoloid characteristics with 11 having other recognizable abnormal conditions and 29 not having information available.

The developmental histories were replete with reports of late development. It should, however, be kept in mind that this information was dependent upon the recall of parents. Only six subjects were reported to have sat without support before the age of 10 months. Forty-three had no information available. Walking alone did not occur before the age of 19 months except for 13 patients. Thirty did not have information available and eight still could not walk. (The possibility should be kept in mind that the eight subjects who could not walk might be chronologically very young.) The age of appearance of the first word was one of the items where very little information was available. Fifty-four of the case records did not report age of first word (15 of the children were still unable to say words). Only three said their first words before the age of 19 months. The age at which the child was first weaned was not available in 60 of the subjects. The remainder were fairly widely distributed over the age range from under 10 months to over 27 months. The age at which the child completed toilet training was usually not available.

Fifty-seven of the subjects did not have this notation available; 19 of the subjects were not yet toilet trained; only 12 were toilet trained at or earlier than six years of age.

Age of separation from the mother or mother substitute indicated that seven children were separated at less than three months, nine were separated between the ages 4 and 12 months, and another 11 were separated in their second year. Eighteen were separated in their third and fourth years of life and the remainder at later ages.

The home situation indicated that with 55 of the subjects their family group was intact and they were giving some care to the patient. In 20 of the instances the family group was broken through death or separation. In 64 cases no history of retardation in the family was present; in 22 some history was present. In 61 of the cases no history of psychiatric deviation in the family present; in 23 cases some history was present. The records of 66 of the children contained no mention of convulsions (other than febrile), while 26 of the patients had records of convulsions.

The histories of visual and auditory impairment taken together were particularly interesting. In 69 of the cases, no history of visual impairment was suggested. In 63 of the cases, no history of auditory impairment was suggested. Comments or suggestions related to visual impairment was present with 24 patients and comments or suggestions related to auditory impairment was present with 30 patients. One might estimate that auditory impairment would be frequently suspected in mentally retarded children. It may be that the "judge bias" for suspecting such problems in this population can be viewed as the frequency with which another sensory deficit is suspected since visual and auditory problems were reported in similar numbers. Another

possibility is, of course, that visual and auditory problems do occur with equal frequency in this population.

In 73 of the instances in the patients' records, no history of severe economic deprivation was suggested. In 18 instances history of such deprivation was indicated in the record.

The referral for institutionalization in 40 of the 93 patients was made by the family physician. Thirty-seven other patients were referred by a physician other than that designated as a family physician. Pediatricians referred eight patients. No patients were referred for institutionalization by a psychiatrist and only three by a clinical psychologist. Referrals were made in 60 instances by physicians undesignated as to speciality.

The foregoing information would be of greater significance if records were available as to the remainder of patients in the institution at comparable age levels. Certain tentative conclusions may be drawn, however, as to the characteristics of this specific group. Among these are:

(1) Recognition of an auditory problem in the group under study did not appear significantly more frequently than suspected visual impairment. Although these two may go together, it seems likely that since suspicion of auditory impairment occurred in only one in every three instances, that improved definition of this area was needed.

(2) The mothers of these patients were not primarily older women. That is, only 27 of the 93 mothers were over age 30 at the time the child was born. Likewise, birth weight of these patients was not a cause for suspecting difficulty. That is, all but twelve weighed over five pounds at birth.

(3) This group was not primarily characterized by medically reported

prematurity, neonatal, or birth difficulties. Only 15 of this group was reported as being premature; only six were born after abnormally long labor. Twelve of the patients were reported as being cyanotic or anoxic at birth or in a neonatal state.

(4) The most striking developmental aspects were: (1) delay in sitting (only six sat before nine months), (2) delay in walking (only 13 walked before 19 months), and (3) delay in the age at which the child said his first word (only three did this before 18 months). The information tended to identify this group as being developmentally severely retarded. Although historically inference might be made on the basis of such developmental retardation that these patients were, in fact, "only" retarded, it should be kept in mind that the reason they were identified as retarded might also have been because of their slow developmental state. The reason for their slow developmental state may or may not have been retardation.

(5) It was of interest to find that 48 of these patients were separated from their parents after the age of four years and that 45 of the patients were separated from their parents at four years or earlier. The possibility exists that some of the problems which characterized this latter group may have resulted from or been magnified by this early separation and the concomitant effects of a less stimulating institutional environment.

(6) Referral of the large majority of these patients to the institution was made by family physicians, physicians who did not designate themselves as to speciality, and by pediatricians. This may explain in part the difficulty in clear identification of the patient's auditory situation as noted in conclusion (1); that is, comprehensive hearing testing would ordinarily be beyond the scope of these medical personnel.

One of the implications of the foregoing conclusions is that arrangements should be made for referral from physicians to appropriate hearing testing to enable definition of the auditory situation of children before institutionalization. Such testing should apparently be prepared to evaluate adequately patients below the age of four years chronologically and probably far below this point in developmental state. Referral for hearing testing cannot be based, at this time, on the presence of positive history of hearing difficulty or other likely medical or physical history.

PSYCHOLOGICAL EVALUATION

Problem.

It appeared as though psychological testing of the patients suspected of hearing loss might reveal valuable information. Clinical impressions and test data in regard to the responses on psychological testing of patients with suspected hearing loss might reveal added information for more certain identification of hearing loss. Identifying the psychological characteristics of patients suspected of hearing loss might have value in retrospective analyses. This procedure was also intended to evaluate the utility of various psychological tests with this type of patient. The specific problem dealt with here was the psychological testing of patients suspected of hearing loss following the free field live voice screening procedure.

Method.

Subjects. One hundred and seventeen patients were seen for psychological evaluation. This group had a mean age of 17.67. The age range of patients tested is presented in intervals in Table 6. Thirty-six patients age 0-5 were seen and 28 patients age 6-10 as well as 13 patients age 11-15. It points out the heavy emphasis in psychological testing on evaluation of the younger age

Table 6

Breakdown, by Age, of Number of Patients Given Psychological Tests

Age	0-5	6-10	11-15	16-20	21-25	26-30	31-40	41-50	51-60	61+
Number of Patients	36	28	13	8	0	3	8	11	10	0

group. These patients were the total group referred as the result of the FFLV test. Included were all patients from the SOP group and groups one, three, five, and seven of the "further testing" group. Only 32 patients over age 20 were evaluated psychologically. Patients over age 20 were selected on a random basis from the total available in order to obtain a measure of the situation of subjects beyond age 20 years.

Procedure. A psychological report form was constructed and utilized under the supervision of a child psychiatrist. This was intended to include as many areas of significance as possible for the patients to be tested. The report form is contained in Appendix E. Psychological tests were evaluated on a sample group of 30 children randomly selected from the institution. One of the major problems encountered in using standardized tests on this population was that the large majority of the young patients (under 11 years of age) failed all sub-tests. Identification of the characteristics of the population was difficult because of a lack of scorable test responses. The first attempt at psychological testing, for example, resulted in 100 per cent of 30 children randomly selected failing all sub-tests on the Arthur Point Scale and the Hiskey Test. Fifty per cent of these patients failed the Stanford Binet sub-tests in total and 33 per cent failed the Cattell Infant Intelligence Scale in total. The Goodenough Draw-a-Man test was not useful in that only one of the children was able to draw a simple circle.

The tests ultimately used with the bulk of the population were the Cattell Infant Intelligence Scale, the Gesell Developmental Schedules, the Vineland Social Maturity Scale, the Leiter International Performance Scale, and the Peabody Picture Vocabulary Test. These tests were found to result in scorable responses more frequently than other tests considered. Every test

was not utilized with every patient; that is, the psychologist selected a test which she thought appropriate to the age level and situation of the child. The IQ obtained was tabulated according to the IQ category on the psychological report form. Appendix F presents the item by item breakdown for the psychological report.

Results and Conclusions.

An estimate of the consistency of judge rating from the psychological testing and rating scales was obtained by randomly selecting 16 subjects for retesting. This was done after a two to six month time interval. These results are presented in Appendix G in terms of percent of agreement for each item on the psychological report form. Intelligence and social quotients were in the same category from test to retest in 79 per cent of the cases. The average percent of agreement for all items from test to retest was 66 per cent, indicating that for two of every three items similar findings resulted when the patient was retested. This was interpreted to mean that sufficiently reliable data was obtained to warrant further interpretation.

The results of psychological testing are presented in Appendix F in the form of an item by item frequency count for each category. The first area evaluated psychologically was that of intelligence quotient. Thirty-six of the subjects were untestable by any test procedure utilized. Thirty-nine of the subjects scored below an IQ of 20, 25 scored between 21 and 35, and only 15 were above 35 in IQ. This seemed to indicate that this population was characterized by severe and profound retardation, as defined by the test procedures utilized, as well as not being testable by standardized tests. It should be pointed out that since these subjects were selected on the basis of suspected hearing loss, this may have influenced their test ability on

standardized psychological tests.

Wood (49) found that estimated potential IQ was a fair index of whether the child was innately retarded or whether some other factor such as language disturbance or brain injury was present. In this study it was impossible to estimate potential IQ in 28 cases. In 60 cases the psychologist estimated that potential IQ was the same as tested; in 24 cases the estimated potential IQ was higher than tested. The social quotients were found to be easier to determine since these did not depend on specific responses of the subjects. Thirty-seven were found to function in the 11-25 social quotient range. Eighteen were in the 26-35 range and 13 in the 36-50 range. Only five subjects were above a social quotient of 50. It is interesting to note that social quotients were higher than intelligence quotients on this population even though the subjects had been institutionalized for some time, in most cases, and one would not expect the social ability to develop more, certainly, than the intelligence quotient. This may, however, result from the fact that the Vineland, especially at the lower age levels, measures environmental manipulation which is dependent upon physiological development rather than social intercourse.

In order to identify other psychological characteristics, rating scales were employed. It should be noted that some subjects were not rated on specific items of the rating scales where they did not apply. For example, rating of children on picture identification if blind was not possible. Accordingly, the totals rated on each rating scale varies from the total number of patients given psychological tests. Rating scale data were included primarily as descriptive information relating to the nature of the population surveyed. A summary tabulation of psychological rating scale data is presented

in Appendix F.

The first scale rated was attention span. It indicated that with 15 of the subjects it was not possible to determine their attention span because of extreme variability, etc. Thirty-three of the subjects were found to have an extremely short attention span and 16 were found with prolonged attention span. Twenty-nine were found to be average in attention span.

Motoric activity was evaluated in terms of hypo or hyperactivity. Twenty-six of the subjects were found to be severely hypoactive with 13 severely hyperactive. The other patients ranged between these two extremes.

Perseveration was present to a severe degree in 17 of the subjects. It was impossible to make any determination of the degree of perseveration with the other patients. The degree to which this population reacted to new situations was rated. Four of the subjects were found to willingly approach a new situation with no fear. Eighty-three were found to be neutral in regard to new situations, 25 withdrew, and with two it was impossible to determine this variable. The degree of dependence was evaluated and 75 of the subjects were found to be autonomous in their functioning. They did not relate in the sense of exhibiting a need for other persons. Thirty-seven were found to either have realistic interdependence, over dependence, or to make continuing efforts unaided when another person might be of value to him in a task. The high degree of autonomous functioning might indicate the effect of institutionalization; that is, most of the patients involved were, in effect, required to function autonomously. It is possible that other children in the institution, suspected of hearing loss, may exhibit a similar manner of functioning. It is also possible that children outside of the institution would be similarly rated.

Stereotypy was evaluated in terms of whether repetitive behavior existed to a large extent. Seven were found to have much stereotypy in their behavioral pattern. Ability to postpone gratification was evaluated. Seventy-four were found to be able to delay satisfaction if they were expected to do so. An additional 16 were found to occasionally want immediate satisfaction but ordinarily be able to wait for rewards. Eighteen were found to have some difficulty in postponing gratification.

Ninety-two subjects were found to have a definite response to sound, 10 to have questionable responses, and 10 to have no response, while one was impossible to evaluate in the psychological test situation using gross sound procedures. This information was based on the psychological examiners experience with the child in the test situation. Naturally, the subjects identified as having difficulty in hearing were ordinarily ones with ability to hear speech but who had difficulty at the softer levels of conversation. In other words, it would be expected that they would have ability to respond to sound. One of the primary purposes for including this procedure was to provide comparative information between the impressions of the psychologist and the results of the controlled hearing testing. It was felt that the discrepancies which existed between the results of these two measures could, in large part, be attributed to the methods employed. Since the psychologist was utilizing a small bell as a sound stimulus there was considerable variance in the intensity level of each presentation. The possibility of obtaining a visual rather than an auditory response was, of course, an inherent variable and one which was not easily detected or controlled under these kinds of procedures. Thus it was felt that perhaps these obtained differences in results illustrate and typify the frequently encountered confusion which

seems to exist among other professional disciplines and lay groups regarding the existence of hearing loss.

Degree of cooperativeness was rated where this was possible to determine. Nine were found to be very cooperative and 19 uncooperative. The compensatory use of other senses was evaluated where possible with hearing loss and blind children. In nine subjects compensatory use of senses was observed. In 19, a definite lack of compensatory use of senses was observed. The amount of fear observed, as reflected in the child's behavior, was rated. Only three children were found to have predominately fearful type behavior.

Anxiety was evaluated in terms of whether minimal anxiety, expected amount, or predominate anxiety was present. Only seven patients were found to have predominately anxious behavior. The patients' reaction to anxiety was evaluated. Eight of the patients became uncontrollable in anxiety producing situations. Drooling was observed with 22 of the patients to a moderate degree and in three to a severe degree. Tremors were observed in six of the patients to a moderate degree and one to a severe degree. Psychomotor disturbances such as head banging and rocking were found in 27 of the patients to a mild degree and in 22 to a severe degree. Sixty-five of the patients had no psychomotor disturbances observed.

Comprehension appeared to be one of the more serious problems in this group of patients. Fifty-eight did not respond to verbal instructions at all. Twenty-six had some comprehension but it was not always consistent or dependable. Only 30 patients had adequate comprehension. It should be pointed out that comprehension may have been affected not only by institutionalization, retardation, emotional difficulty, and brain injury, but also by the fact that the group was selected as being suspected of hearing loss.

Comprehension of speech was not, however, disturbed in about one-fourth of the patients. Speech production was evaluated by the psychologist in terms of language development. Only 22 of the patients used sentences. Thirteen used either single words or phrases, 12 used jargon speech, and 63 were without usable language. The presence of unusual speech was likewise investigated. Only one child was found to have echolalia and no children were found to have word salad or neologisms in their speech pattern. Sixty-three of the patients were found who did not attempt communication in any manner, 16 had obvious non-verbal communication, and six attempted to communicate verbally at times. Twenty-seven had obvious verbal communication of thoughts, wants, ideas, and messages. The patients' responses to communication were evaluated. Thirty-five were found to have appropriate responses, 24 to respond at times, and 54 to have either no response or inappropriate responses. The results of this scale appear similar to the one of comprehension ability. The patients' ability in prehension was also rated. Fine prehensile ability was observed in 53 subjects, 35 were found to have crude prehensile abilities, 7 had no prehensile ability, 9 could grasp, and 6 could transfer.

Cerebral dominance was evaluated. With 55 patients it was impossible to determine, 15 were found to be left-handed, and 43 right-handed. Perceptual disturbances in the sense of psychological testing were investigated. With 72 of the patients it was impossible to determine whether they had a perceptual disturbance. Twenty-three of the patients had no perceptual disturbance, two had mild, and two had severe perceptual disturbance. The degree of emotional disturbance was evaluated by whether bizarre behavior was present occasionally or predominately. Such behavior was found in 52 of the patients. No determination could be made for five of the patients. Imagination was

found to be extremely concrete in 73 patients, 17 had minimal fantasy life, 3 had much fantasy, and 1 was found to be creative in new uses of tools and toys.

The following of simple commands was evaluated on whether one or more commands could be followed. Nineteen subjects were found to be able to follow one command, 66 would follow no command, and an additional 16 were found to follow commands easily. Picture identification ability was found to be absent in 60 patients, 22 would point to the appropriate picture, 6 would use words to describe pictures, and 2 gestured towards the pictures. Body parts identification was tested. Sixty-three patients were found to be unable to point to any body parts.

The child's ability with building blocks was evaluated. Sixty-eight of the patients were found to have no ability with blocks, seven could build a tower, two a bridge, and two a train. None of the patients were able to build a gate or steps. Form board solutions were evaluated. Forty-three were unable to solve the form board, four solved it correctly, and three reversed on the Sequin Form Board.

The extent to which the patient sought body contact was evaluated. Twelve were found to move away from personal contact, 17 to perceive people in the environment but not contact and did not respond emotionally, 32 patients were found to permit body contact but not encourage it, and 45 to seek body contact. The degree of emotional expressiveness was rated as apathetic in 56 of the patients. Spontaneous expression was noted in only 25. Affection was found to range from no display of affection under any circumstances with 36 patients through reciprocating affection in 28 patients, to being spontaneously affectionate in 27 patients. Passiveness was found to be average in

56 patients, greater than average in 33 patients, and absent in 16 patients.

Aggressiveness was found to be average in 50 patients, greater than average in 14 patients, and nonexistent in 46 patients. This item was interesting in that apparently these patients were apathetic in large part. That is, 46 had no aggressiveness and 33 were found to be greater than average in passiveness. Degree of destructiveness was of interest in that 63 of the patients were found to not be destructive at all, 29 were thought to have an average amount of destructiveness for their age, and only 12 to be greater than average in destructiveness. Hostility was found to be absent in 78 of the patients, 19 were found to have average hostility, and 7 to have greater than average hostility.

The psychological evaluation results seemed to indicate that the intelligence quotients of the subjects were extremely low. Social quotients were of a higher magnitude but were primarily below 50. The subjects appeared to have definite responses to sound in large part, but to have, in large part, difficulty in comprehension and to make very few attempts in communication. Ability to follow simple commands was limited in cases who responded to speech to no more than one command. Ability to identify pictures or body parts or to build with blocks was almost totally absent in this patient group.

Emotionally, the group was characterized by apathy, passiveness, and absence of aggressiveness, hostility, and destructiveness.

Overall, one may get the impression that the patients identified as suspected of hearing loss, psychologically, had characteristics of severe retardation. Whether difficulty in communication is as frequent in severe retardation is open to question. It should be kept in mind that the large majority of patients given psychological tests were age 10 and below. This,

no doubt, influenced the difficulty in testing and may have resulted in an artificial lowering of scores; i.e. adequate evaluation may not have been possible with the group tested because of their early age and lack of appropriate standardized tests. This points to the lack of adequate psychological evaluative measures suitable for dealing with young institutionalized retardate children, particularly those suspected of having a hearing loss.

OTOLOGICAL EVALUATION

Problem.

Otological consultants were utilized to evaluate the particular problems that might occur in children identified as having suspected hearing loss. It was thought in this way information could be gained as to the physical status of the hearing mechanism and that further clues to hearing status could occur. It was not possible for the otological consultant to see all of the subjects screened out. Accordingly, a priority schedule similar to that used in psychology and social work was established for patients under the age of 20.

Method.

Subjects. The otologist examined 121 subjects. The mean age for these subjects was 21.37 years. Information regarding the age categorization of these subjects is presented in Table 7.

Procedure. An otologist saw each patient for a standard ENT examination. Recording of the medical and physical findings was done on the ENT record form contained in Appendix H. Items regarding the medical histories of the patients seen were completed in advance of the examination by the project social worker. Followup on individual patients was carried out where necessary to further define the medical or physical condition.

Table 7

Number of Patients, by Age, Seen for Otological Examination

Age	0-5	6-10	11-15	16-20	21-25	26-30	31-40	41-50	51-60	61+
Number of Patients	23	30	13	9	6	5	9	11	12	3

Results and Conclusions.

The results of the otological findings are presented in Appendices I and J in the form of an item by item frequency count. Interpretation of the major results of this analysis follows.

Twenty-eight of these subjects were found to have normal ENT examination results. Twenty-one of these same subjects were identified by the otologist as having normal hearing. Seventeen were found to be impossible to assess. Fifty-five were identified as having hearing impairment. Of the subjects so identified, 18 of these were thought to be of perceptive and 19 of conductive etiology. Of the conductive losses, five resulted from cerumen in the ear canal, 13 from otitis media, and one from unknown etiology. Otosclerosis was identified in one patient and presbycusis in two. Two distinct medical problems were identified in seven of the patients examined and three distinct medical problems identified in one patient examined. The otologist also identified from unknown etiology one case as having mild hearing loss, two as having moderate hearing loss, three as having a profound hearing loss, and one as being deafened.

History of ear disease was recognized in 14 patients. Five of these involved pain in the ear, 14 had drainage, 10 had deafness, 1 had ear surgery, and 24 patients were found to have had a T & A.

The social work evaluation indicated that four of the patients had a family history of deafness or ear disease. Rubella during the first trimester was found in the case of one patient. Three patients had a history of head trauma and three had a history of central nervous system disease.

Physical examination of the ears resulted in 27 subjects having some positive indication of difficulty although not necessarily accompanied by

indications of hearing loss. Twenty-six of these were identified as being present in the external canals. Twenty-five were identified as having such difficulty in the tympanic membrane and 17 as having difficulty in the middle ear. The ossicular chain was thought to be disrupted in four of the subjects. It should be kept in mind that the data on physical examination of the ears no doubt overlapped. For example, a subject with a tympanic membrane affected often had recognizable difficulty in the external canal from drainage in the middle ear.

Gross hearing tests were found to be positive; that is, a recognizable difficulty was found in 47 patients. These, however, represent only responses to gross sounds. Tuning fork tests indicated hearing loss in 20 of the patients. Weber's test and Rinne's test each resulted in recognition of difficulty in 9 patients each.

Recognizable difficulty was found in the nose of 26 patients, in the oral pharynx in 20 patients, in the nasal pharynx in 15 patients, and in the neck in four patients.

Overall, the physical data provided by the otological examination and the history uncovered by the otologist tended to substantiate the diagnosis of hearing loss in more than half of the patients screened out by the free field live voice and pure tone test procedures.

The implications of this appeared to be that hearing loss in this population resulted from a wide variety of etiologies. Some of these, such as otitis media and cerumen in the ear canal, were found to be active at the time of the examination. The implication of this may be that additional preventative procedures should be begun in institutions such as state homes to avoid complication of retardation as the result of preventable hearing

loss. A further implication is that the hearing test procedures employed appeared to be valid in at least half of the patients so identified. The remainder could not be said to be invalid since they may have had hearing loss resulting from an obscure etiology or were impossible to assess with the test procedures available to the otologist because of their behavior or other factors.

SECTION IV
HEARING TEST DEVELOPMENT

ELECTROENCEPHALIC RESPONSE AUDIOMETRY (EER)

Problem.

EER-Audio was included among the procedures to be evaluated in the course of this study since it represented, along with the electrodermal techniques, an attempt at a different measure of audition. The need for such procedures was apparent from the complexity of the problem of testing the hearing of the mentally retarded. The problems encountered with that portion of the population untestable by any of the attempted procedures made it apparent that some measure of auditory response was needed which was less demanding of the patient in terms of learning or conditioning and which could be carried out in the presence of a wide range of atypical behavior.

An investigation of the use of electroencephalography as a screening device was undertaken with the underlying philosophy that if such a technique was to have widespread practical application in other institutions for the mentally retarded, it should be accomplished with equipment most readily available to such institutions. Thus a computer was not utilized and an attempt was made to devise a procedure for reading and scoring EEG tracings which would serve as an audiometric screening device and which could be accomplished visually and manually.

Method.

Subjects. Subjects were 20 mentally retarded patients under the age of 17 years (mean CA of 10.6 years) randomly selected from the following four subgroups.

Normal Hearing - patients who exhibited thresholds of 20 db or less by

standard pure tone procedures.

Hearing Loss - patients who exhibited thresholds greater than 20 db by standard pure tone procedures or whose loss was confirmed by otological examination.

Inconsistent Responders - patients who had failed FFLV test and passed it on retest.

Unknown Hearing Status - patients who had consistently failed all attempts at hearing assessment.

Equipment. All EER-Audio testing was carried out in the sound isolated room described earlier. The pure tone audiometer and speech circuit of the control panel were utilized for the administration of all stimuli. Clicks were produced by means of a toy cricket or snapper and fed through the speech circuit. An Offner eight-channel electroencephalograph, Model 704-A, was employed for recording brain wave patterns. In addition, since it was imperative for scoring purposes to mark the onset and termination of all stimuli presented on the EEG tracing, a "stimulus indicator" was constructed. This electronic device employed the amplifier and circuitry of a Precision Table Aid, Model 3AC21-AVC, which were modified to change any A.C. voltage on the sound room speaker circuit into D.C. voltage and transmit it to a single pen on the EEG dynograph. In this way the limits of any signal transmitted through any one of the four speakers within the sound room were recorded on the tracing.

Procedure. All of the EER-Audio testing and scoring procedures attempted were adaptations of techniques suggested by Derbyshire (10). Because of the difficulties encountered in placing and maintaining electrodes with a large number of the population involved, only three electrodes were employed. These

were positioned, with bentonite paste, over the following areas of the cortex: left premotor, left frontal, right frontal, and right earlobe. Recordings were made between the left premotor and left frontal electrodes and the right earlobe placements. The right frontal lead was used as a ground. These positions approximate the F₃, Fp₁, Fp₂, and A₂ positions on the international ten-twenty system. It was recognized that the use of such a small number of recording electrodes obviated the possibility of any assessment of cortical pathology. Since, however, clinical electroencephalography was not the principle purpose of the procedure and since it was hypothesized that EEG responses to auditory stimulation are the results of the activity in the associative and reticular paths of the C.N.S. and are diffuse in nature, the number and placement of electrodes were not considered to be critical factors. The electroencephalograph was calibrated with 50uv equal to one centimeter of pen deflection. The high filters were set at maximum to reduce the recording of muscle artifact. Paper speed was 5 centimeters per second.

The stimuli employed for all EER-Audio testing consisted of a pure tone at 1000 cps, three clicks in rapid succession, and three consecutive live voice presentations utilizing the patient's name. These were presented at three intensity levels, 20, 40, and 60 db. All presentations were of approximately 5 second duration. Each of the three stimuli, pure tone, click, and live voice were presented 12 times at each intensity level. Thus each test was composed of nine series (three stimuli at three intensities) with 12 presentations in each. The order in which the series were to be presented was determined by random selection prior to the administration of each test. As a result of the experimental alterations which were made in the evaluation

procedures (described below), two methods were ultimately employed for the selection of the "no-stimulus" or control periods. The first of these involved the random selection of an interval of tracing, equal in length to the stimulus period and selected from an area of the tracing between the stimulus presentation areas. For each test a total of nine such control periods were marked off and considered as periods of no stimulation. Each of these corresponded to one of the various stimuli series. The second method consisted of marking off an area of trace equal in length to the stimulus periods and immediately preceding each one. Thus the terminal point of the no-stimulus period was the initiating marker of the stimulus.

Three separate methods of evaluating electroencephalic responses were developed and investigated. These were referred to, for identification purposes, as the "direct-reading method" (DRM), the "projected-superimposition method" (PSM), and the "traced-superimposition method" (TSM).

The DRM was the initial procedure attempted and was similar to the one described by Derbyshire and Farley (9). This involved marking directly on the EEG tracing with red pencil an identifying symbol for each stimulus presented while the test was in progress. At the conclusion of the test the no-stimulus periods were randomly selected, as described above, and also were marked in red. At a later time two judges, wearing red goggles which obliterated the stimulus and no-stimulus identification marks, independently scored all of the presentations throughout a given test. Increases in the amplitude of the tracing, suppression of existing activity, and the introduction of new patterns were used as response criteria. Numerical values from 1 to 4 were assigned to represent gradations of any responses detected. It was apparent after a number of trials that this procedure required a consistency or

reliability of judgment which could only be achieved after considerable practice and experience in judging. It was consequently abandoned in favor of the second technique (PSM) which was thought might alleviate these difficulties.

The PSM method made use of a dry diazo type transparency reproduction system. Individual stimulus and randomly selected no-stimulus presentations were cut from each completed EEG tracing. The extraction of the desired area of trace from the overall tracing was necessary to conserve the light sensitive paper used in the reproducing system. Transparencies with coded identification markers and stimulus-onset markers were prepared for each presentation in each of the series. To insure an equal area of trace for all transparencies, an inked line was extended perpendicular from the top edge of the recording paper, through the stimulus-onset marker, and across the baseline of the recording tracing. A rectangular area of the recording paper $1\frac{1}{2}$ inches above and $1\frac{1}{2}$ inches below the baseline of the recorded tracing, 3 inches preceding and 7 inches following the stimulus-onset marker was then removed and reproduced as a transparency. In the preparation of the no-stimulus series, arbitrary onset markers were established. After these preparatory measures had been completed, the nine stimulus series and three no-stimulus series were randomly selected in the following manner.

Two judges were seated before a screen with score sheets placed before them (Appendix K). The first three transparencies from a series were projected to a screen from an overhead projector and the judges, by mutual agreement, selected one transparency from the first three to be used as a template-of-response. The criteria for this selection was the approximation, in shape and position, of some part of the tracing pattern to the evoked-potential response reported by Derbyshire (9). From this point in the evaluation procedure no further communication was allowed between the judges. The

selected template was retained on the projector and all of the transparencies in the series were singly superimposed and aligned vertically and horizontally upon it. The judges then scored each superimposition for match using the numbers 2 through 5 to represent degrees of "goodness of fit" and the number 1 to represent the absence of match.

On examination of the resultant data from some preliminary trials utilizing the PSM and at Dr. Derbyshire's suggestion, this procedure was altered in a manner which it was felt would result in a more sensitive evaluative procedure. The following modifications were incorporated to give added sensitivity to variances in the pattern, such as, increases in amplitude and depressions of the tracing. The method for the selection of the no-stimulus periods was changed to the second procedure described above with equal amounts of area allotted to the stimulus and no-stimulus periods and with the onset-marker as the dividing line, centered on the transparency. Thus each stimulus presentation was paired with the no-stimulus period that preceded it. The superimposition of each transparency series was accomplished by matching the points at which the tracing crossed the onset-marker aligned vertically and parallel horizontally. All of the presentations within a single series were simultaneously matched and projected. Alterations in the judging procedure involved scoring, with the numerical system described above, the pre-stimulus and post-stimulus areas on each transparency. Since an artificial clustering had been induced by matching the points at which the trace crossed the onset marker, a suppression of the pattern at this point was expected and produced. A random pattern of scatter, within the response limits of the dynograph, prior to and following this period of suppression was hypothesized. The criteria for response scores were thus changes in the

expected pattern prior to or following the onset of stimulation, evoked potentials or patterning of several of the overlaid traces and unequal or extended periods of suppression preceding or following the point of match.

The preparation of the transparencies utilized in the PSM proved to be a lengthy and relatively expensive process. The preparatory procedures necessary for one complete EER test involved approximately $3\frac{1}{2}$ hours with an additional $2\frac{1}{2}$ hours necessary for evaluation. The total cost of the supplies for the reproduction process was slightly over four dollars per subject. In an attempt to alleviate these inherent adversities, the following modifications were incorporated and the resulting method was referred to as the "Traced Superimposition Method" (TSM).

All of the presentations in a given series were manually superimposed in red pencil on tracing paper. Goggles with red lens were used by the person engaged in the tracing process to obliterate the red lines as they were drawn and thus prevent the cumulative interference to the tracing process which the progressive superimpositions afforded. The resultant tracings were acceptable duplications of the superimposed, projected transparencies utilized in the PSM and could be prepared and judged in less than one half of the time involved in the latter. The costs of the tracing paper relative to the costs involved in the preparation of transparencies was negligible.

Several variations in the application of the previously described numerical system of scoring were developed and investigated for use with the TSM. Four possible methods evolved and were evaluated on a pilot basis as follows:

(1) The difference method. This method involved assigning a number from one through five to identify the extent of any difference which might exist between the pre-stimulus and post-stimulus periods. The numbers 2, 3, 4, and

5 were used to indicate the magnitude of such differences and a 1 was assigned to those cases where no such difference was apparent to the judge.

(2) The ratio method. This procedure consisted of scoring the pre-stimulus and post-stimulus periods individually using the criteria of change previously described. The numbers two through five were used to indicate the gradations of such changes and the number one was assigned when no variations were apparent. The resultant scores were recorded on a score sheet (Appendix L) as a fraction with the stimulus score representing the numerator and the no-stimulus score the denominator. The final response score was obtained by subtracting the denominator from the numerator. When a higher number was assigned to the pre-stimulus period the subtraction was not completed and the tracing was scored as a one.

(3) The third method was similar to method (2) and was called the Corrected Ratio Method. The only variation was in subtracting the number assigned to the pre-stimulus period from the post-stimulus period although it might be larger. This resulted in the possibility of minus numbers being assigned but was thought to be potentially more sensitive.

(4) The stimulus method. The application of the procedure involved assigning a score to only the post-stimulus period.

The above four methods were evaluated by means of comparing test results on five hearing loss subjects and five subjects without hearing loss. The hearing loss subjects were selected on the basis of medically identified hearing loss, failure to respond to sound in a free field testing environment, and behavior indicative of a hearing loss. Subjects without hearing loss were selected by their ability to respond to sound at normal intensity levels as indicated by pure tone audiometry and free field live voice testing. The

mean age for the hearing loss subjects was 10.2 years; for the subjects without hearing loss it was 10.7 years.

Table 8 presents t values of the judging and scoring systems for the varied intensity levels as contrasted with the ratings for no stimuli. That is, scores were obtained for each subject at the varied intensity levels on the varied scoring systems and then compared with the no-stimuli scores. Inspection of Table 8 indicates that in no case was it possible to discriminate at a significant level between no-stimuli presentations and the 20 db presentations. This was also true of all intensity levels for the hearing loss subjects. All comparisons at 40 db for the subjects without hearing loss were statistically different from zero. The comparisons on the ratio method and the corrected ratio method were also statistically significant.

On the basis of these comparisons, the ratio method appeared to discriminate more adequately as a judging and scoring system. All subsequent judging and scoring of EEG was done using the corrected ratio method.

Results and Conclusions.

Data were analyzed employing a Lindquist Type VI Mixed Design (28) analysis of variance with subgroups as the between factor and db level and responses to stimulus or no-stimulus as the within factors. Values used in this analysis were obtained by the scoring method described previously for EER-Audio. A summary of this analysis is given in Table 9. Hartley's Test of the variances indicated they were extremely heterogeneous. In view of this extreme heterogeneity, critical values were obtained by referring to the table values for the .01 level of significance and interpreted at the .05 level. This procedure appeared advisable on the basis of the Norton study (28) which recommended that a more stringent significance be applied in cases of

Table 8

T Comparisons of Judging and Scoring Systems on EEG Recordings
(Totals Assigned Stimuli - Totals Assigned No Stimuli)

	Difference Method			Ratio Method		Stimulus Only		C. Ratio Method	
		t	SD	t	SD	t	SD	t	SD
Hearing Loss Subjects	20 db	.0	4.58	1.83	2.70	1.54	2.92	2.03	2.64
	40 db	.53	4.47	.47	3.84	.74	4.30	.22	4.16
	60 db	.0	3.00	.88	1.51	.21	2.16	.59	1.52
No Hearing Loss Subjects	20 db	1.08	2.50	.48	4.64	.29	4.60	.91	3.91
	40 db	3.77*	1.65	7.04**	1.58	3.33*	3.30	6.13**	1.67
	60 db	1.62	4.72	3.14*	3.42	2.42	5.00	3.56*	3.03

*p. < .05

**p. < .01

Table 9

Summary of Analysis of Variance EER-Audio Raw Scores
(Lindquist Type VI)

Source	df	S ²	F
Between <u>Ss</u>	19	14.63	
C (groups)	3	46.19	5.30*
error (b)	16	8.71	
Within <u>Ss</u>	100	10.36	
A (db)	2	25.31	4.15
B (S-NS)	1	326.70	39.18*
AB	2	27.08	5.99*
AC	6	5.23	.86
BC	3	25.97	3.11
ABC	6	3.71	.82
error (w)	80	5.91	
error ₁ (w)	32	6.09	
error ₂ (w)	16	8.34	
error ₃ (w)	32	4.52	
TOTAL	119		

*p. < .05 - Read from table at .01 level

heterogeneous variances to avoid understating the probability of an alpha error.

Results of this analysis showed that between groups main effect and the interaction between db level and responses to stimulus or no-stimulus were significant. Analysis of the partial between groups main effect indicated the mean response of the Hearing Loss group was significantly less than that of the No Hearing Loss group. In addition, the No Hearing Loss group had a significantly greater mean response than the Inconsistent group or the Unknown group.

To test the interaction between db level and stimulus or no-stimulus, the data were subjected to Treatment X Subjects Designs (28). The results of these analyses are seen in Tables 10, 11, 12, 13, and 14.

Inspection of these analyses revealed a significant simple effect upon the three db levels when a stimulus was presented. In addition, a significant simple effect at both 40 and 60 db when comparing stimulus against no-stimulus was noted.

As may be seen by the results, groups responded less at 20 db than they did at 40 or 60 db when a stimulus was presented. It may also be concluded that groups responded greater to a stimulus than no-stimulus at both 40 and 60 db.

A second Lindquist Type VI Mixed Design was then utilized using units obtained by converting the original raw scores into reciprocals. This seemed advisable in view of the extreme heterogeneity of variance. Hartley's Test of the transformed scores indicated that they were equal. Table 15 summarized this analysis. All F values were interpreted at the .05 level of significance.

The result of this analysis was similar to the one previously described

Table 10

Treatment x Subjects Analysis of Variance of Simple Effect EER-Audio
(20 db - Stimulus, No Stimulus)

Source	df	S^2	F
A (stimulus, no stimulus)	1	19.60	4.26
S (subjects)	19	4.56	
AS (treatment x subjects)	19	4.60	
TOTAL	39		

Table 11

Treatment x Subjects Analysis of Variance of Simple Effect EER-Audio
(40 db - Stimulus, No Stimulus)

Source	df	S ²	F
A (stimulus, no stimulus)	1	180.63	22.01*
S (subjects)	19	12.03	
AS (treatment x subject)	19	8.20	
TOTAL	39		

*p. < .05 - Read from table at .01 level

Table 12

Treatment x Subjects Analysis of Variance of Simple Effect EER-Audio
(60 db - Stimulus, No Stimulus)

Source	df	S ²	F
A (stimulus, no stimulus)	1	180.62	25.44*
S (subjects)	19	9.96	
AS	19	7.10	
TOTAL	39		

*p. < .05 - Read from table at .01 level

Table 13

Treatment x Subjects Analysis of Variance of Simple Effect EER-Audio
(Stimulus, db Level)

Source	df	S ²	F
A (db level)	2	52.36	5.59*
S (subjects)	19	23.52	
AS (treatment x subjects)	38	9.35	
TOTAL	59		

*p. < .05 - Read from table at .01 level

Table 14

Treatment x Subjects Analysis of Variance of Simple Effect EER-Audio
(No Stimulus, db Level)

Source	df	S ²	F
A (db level)	2	.07	.07
S (subjects)	19	2.23	
AS (treatment x subjects)	38	1.00	
TOTAL	59		

Table 15

Summary of Analysis of Variance (EER-Audio Transformed Scores)
(Lindquist Type VI)

Source	df	s ²	F
Between <u>Ss</u>	19		
C (groups)	3	.003613	3.195
error (b)	16	.001131	
Within <u>Ss</u>	100		
A (db)	2	.002201	3.325*
B (stimulus-no stimulus)	1	.037136	40.541*
AB	2	.002270	4.504*
AC	6	.000769	1.162
BC	3	.001243	1.357
ABC	6	.000318	.631
error (w)	80		
error ₁ (w)	32	.000662	
error ₂ (w)	16	.000916	
error ₃ (w)	32	.000504	
TOTAL	119		

*p. < .05

in that it yielded a significant db level--stimulus or no-stimulus interaction. It did differ, however, with respect to between groups main effect. This analysis did not show a significant between groups main effect. The group means and standard deviations for the EER-Audio raw scores are presented in Table 16.

Several conclusions were possible on the basis of the results indicated previously. These follow:

(1) Although reliability of inter-judge and re-judge data on the corrected ratio scoring method finally utilized in the analysis of variance were sufficiently high ($r = .62$ and $r = .55$), test-retest reliability was low ($r = .20$). This appeared to indicate that although the test and judging procedures were adequately reliable, the difference between one judging situation and another resulted in scores which did not have significant relationships to each other. This appeared to indicate that variability existed in the subject's response to the test situation to the point where adequate information in regard to all possible test behavior was not possible from one test situation.

(2) The analysis of variance of the data obtained indicated that significant differentiations were made between stimulus and no-stimulus presentations at the 40 and 60 db level. Differentiation at the 20 db level did not occur.

(3) Differentiation between the no hearing group and the three other groups evaluated was obtained. Significant differences were not seen, however, between the hearing loss group and the unknown group and the inconsistent group. The utility of EER-Audio in differentiating subjects with hearing loss from unknown or inconsistent categories appeared to be slight. The value in differentiating subjects with normal hearing from the other three categories

Table 16
Group Means and SD for EER-Audio Raw Scores
(By db Level and Stimulus-No Stimulus)

	20 db				40 db				60 db				Total			
	S		NS		S		NS		S		NS		S		NS	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
HL	8.00	1.00	7.00	1.23	11.40	5.64	6.80	.45	9.80	3.96	7.20	1.30	29.20	7.63	21.00	2.35
NHL	10.80	4.55	7.80	1.48	15.60	2.88	8.00	2.00	14.60	5.27	7.20	1.30	41.00	9.49	23.00	4.00
INC	7.40	.89	6.80	1.10	8.80	2.77	6.20	.45	2.00	2.00	7.00	.71	28.20	2.50	20.00	2.00
UNK	8.20	2.28	7.20	1.30	9.60	2.61	7.40	.55	9.40	2.51	7.40	1.34	27.20	9.93	22.00	1.42

HL = Hearing Loss
NHL = No Hearing Loss
INC = Inconsistent
UNK = Unknown

was evidenced.

This test procedure did appear to identify subjects with normal hearing at the 40 and 60 db level. It did not appear, however, useful as a screening test of hearing since it was not discriminating at a 20 db level nor did it define further the hearing status of the unknown or inconsistent response groups. The extreme variability on test-retest would further tend to limit the utility of the procedure if it was used to measure the function of the ear alone. It seemed that the greatest value in EEG might be as an estimate of potential usefulness of the patient's hearing. That is, where a hearing loss was observed by other procedures, such as historical or medical evidence, EER-Audio might indicate an improved or a worsened situation in regard to hearing. In this kind of situation a predictor in regard to educability of hearing might be shown since it appeared that different kinds of responses were noted under this type of test procedure. That is, EER-Audio may measure arousal ability of the hearing mechanism rather than interpretative or learned functions of hearing. As such, it could be expected to be of value in predicting the utility of training programs even though its usefulness as a screening procedure appeared extremely limited.

Although it was apparent that further experimentation with this method was needed, it was not possible under the limitations of the current project. The possibilities in regard to improving test-retest reliability, for example, were present in the sense of allowing a longer test time with randomly timed stimuli presentations, a longer time interval between groups of stimuli presentations, and the evaluation of responses at 30, 50, and 70 db instead of the ones selected. Such further experimentation would appear of little value unless criterion variables such as success in auditory training are

available.

PALI*

Problem.

Observational data on whether young mentally retarded institutionalized children hear was found to be difficult to quantify. Problems were observed in relating the response of the child to the presence of the stimulus sound as well as in the interpretation of whether a response had occurred by a given judge. The possibility of bias on the part of the judge was present. This bias was thought to operate in the direction of seeing responses when no response might be present; although it could operate in the opposite direction as well. Although common clinical practice has involved procedures such as those utilized in the free field live voice testing procedure described earlier, the present group under study was found to repeatedly fall in the problematic group. That is, it was not possible to adequately differentiate the presence or absence of hearing loss in a sizeable number of the children seen. A more refined testing procedure which would control judge bias and allow for more careful interpretation of observed responses of the subjects was indicated.

Method.

Subjects. In order to obtain comparative data on the test procedure, several subgroups of children in varying hearing categories were tested. Five children were selected from the population of the institution below age 16 who had been able to respond to pure tone testing and who had been found

*PALI is used here and in subsequent discussion to refer to the procedure and sound stimuli employed in this particular experiment. It was adopted as an abbreviation for the descriptive phrase, "Polysound Awareness Level Index".

to have normal hearing. Five children were selected who had well substantiated hearing loss below the age of 16. Their responses were such that it had not been possible to test them using pure tone testing. Their hearing loss, however, was corroborated by otological and history findings. They had previously failed the free field live voice test as well. A group of five children below age 16 was selected who had failed the initial free field live voice test and then on retest had passed this test. This group was thought to be a difficult group to test. They did represent, however, a group which was thought to be normal in hearing after the second hearing test. A fourth group of children whose hearing status was unknown after available hearing tests had been given, including the free field live voice test, were selected from the institutional population below age 16. There were 15 children in this group. They had fallen in the category of hearing status unknown because of the lack of consistent responses to the free field live voice test.

Equipment. The equipment was the same as that used in the FFLV test (see page 24).

Procedure. A sequence of 10 sounds was introduced into the sound room from the free field speakers at calibrated intensity levels of 20, 40, and 60 db loud. These consisted of five voice presentations and five noises which had been recorded on tape to facilitate their replication. The judge, who interpreted whether a response was present or not, heard the 10 sounds the child heard through Rudmose earphones. He also heard 10 additional sounds randomly interspersed with the 10 the child heard through the earphones. The earphones were adjusted at an intensity level which did not permit the child to hear the sounds the judge was hearing or the judge to hear whether or not the child was hearing a particular sound. Judgments were made on a one to

four scale with one representing no response, two representing possible response, three representing probable response, and four representing definite response. The audiologist who controlled the sounds going into the room observed the child and gave the sounds at a time when the child was relatively quiet. That is, a hyperactive child engaged in running around the room did not have a sound presented at that time. The judge observed responses of the child and scored them for all 20 sounds that he heard. Observed responses included such things as turning of the head, eye movement and eye blink, a cessation of movement, or other change in behavioral pattern.

Results and Conclusions.

Fifteen of the children were judged at randomly selected intensity levels again in order to obtain a measure of overall test-retest reliability. The r obtained on rejudgment was .01. This r indicated lack of agreement of test results on test and retest scores. Fifteen other children were judged at randomly selected intensity levels by both judges in order to obtain a measure of overall inter-judge agreement. The r obtained for this inter-judge agreement was .82.

The data were analyzed utilizing Lindquist Type I Mixed Design (28) analysis of variance. Results of the analysis are summarized in Table 17. All F values were interpreted at the .05 level of significance. Hartley's Test of Homogeneity of Variance resulted in heterogeneous variances. In view of the heterogeneity, the critical values were obtained by referring to the table of values for the .005 level. This procedure appeared advisable because of the marked heterogeneity of variances. Lindquist (28), in 1953, on the basis of Norton's study recommends that allowances can be made for heterogeneity of variances by setting a higher level of significance for the tests

Table 17

Summary of Analysis of Variance of PALI Results

(Groups - Intensities)

(Lindquist Type I)

Source	df	S^2	F
Between S_s	29		
B	3	904.77	18.91*
error (b)	26	47.86	
Within S_s	60		
A	2	301.34	20.03*
AB	6	32.18	1.29
error (w)	52	25.03	
TOTAL	89		

*p. < .05 - Read from table at .005 level

of treatment effects than one would otherwise employ.

Inspection of the analysis indicated a significant between groups main effect and a significant db level main effect. There was no significant interaction.

Analysis of partial main effects (between groups) showed that the normal hearing group had a significantly higher mean number of responses than the hearing loss group. In addition, the hearing loss group had a significantly smaller mean number of responses than the unknown group. Analysis of the partial main effect (db level) indicated that differences existed between all intensity levels.

Essentially these results indicated that variance of subjects in the hearing loss group was markedly smaller than the subjects with normal hearing or without hearing loss and the subjects who are unknown in regard to hearing response. Apparently the subjects with hearing loss were found consistently to not respond to sound under this kind of analysis.

This procedure overall appeared to result in adequate differentiation of subjects in the various categories in regard to hearing from those subjects with identified hearing loss. The hard to test subjects appeared to have a distribution quite similar to the unknown subjects. They were differentiated on an individual basis, however, as being either like the hearing loss subjects or like the subjects without hearing loss. Cutoff points were established at a raw score of six (two standard deviations from the mean of the hearing loss subjects) and at 10 (one standard deviation from below the mean of normal hearing subjects. Subjects who fell above the 10 level appeared to have responses quite like normal hearing subjects; at least 66 per cent of the time they fell within that distribution. Subjects with a score of six on the PALI

procedure 93 per cent of the time were two standard deviations from the mean or closer. Subjects who fell between 6 and 10, in other words, who achieved a score of 7, 8, or 9, were most likely in the normal hearing group but no strong statistical evidence was present for this.

The results of analysis of the foregoing data treatments appear to indicate the following:

(1) Although interjudge agreement is sufficiently high, test-retest agreement indicates the measurement of the test performance was not carried out with sufficient reliability. This may be accounted for in terms of behavioral inconsistency. It may also indicate the need for a longer test or a more stable measure of the children's performance.

(2) Even though test-retest reliability was not adequate, the analysis of variance of the data obtained indicated that this procedure did significantly differentiate between some of the subgroups tested and intensities used. Both sources had significant F values ($p < .05$). Interaction between these variables was not significant. Each intensity level was found to be significantly different from each other intensity level with the higher mean number of responses associated with the higher the intensity.

(3) The normal hearing subjects were found to be significantly different than each of the other three subgroups. The hearing loss subjects were not found to be significantly different than the hard to test or the unknown subjects. This would indicate that although subjects with normal hearing could be differentiated by the test procedure, clear delineation of which subjects actually had hearing loss would be difficult.

As a result of the foregoing conclusions, the FALI procedure was further modified with the intent of obtaining more reliable information on test-retest

data and to differentiate hard of hearing children from children in other behavioral categories. Two major modifications were incorporated in the next procedure which is described and the research carried out on it delineated in the following section. These modifications consisted of the removal of the phones from the judge to increase his sensitivity in the detection of responses and a more liberal acceptance of response regardless of type or magnitude.

PALI-2*

Problem.

Previous findings of the study seemed to indicate that free field, sound awareness tests were more useful and economical in evaluating the hearing of a mentally retarded population than other procedures attempted.

The original FFLV test, while effective as a gross screening procedure, pointed up the need for a more discriminating technique. The PALI was the first attempt at such refinement but the resultant deficiencies, as previously described, necessitated further modifications.

This test was designed (PALI-2) requiring a minimal amount of time to administer and necessitating few demands upon the patient being tested.

Method.

Subjects. Subjects were 30 mentally retarded children (17 males and 13 females) selected from the population of the institution. All subjects were between 3.4 and 15.0 years of age (mean CA = 9.0 years, SD = 3.2 years).

*PALI-2 is used here and in subsequent discussion to refer to the procedure and sound stimuli employed in this particular experiment. It was adopted as an abbreviation for the descriptive phrase, "Polysound Awareness Level Index - 2".

Complete information was not available on the IQ's or MA's of the subjects due to the lack of test records on younger subjects. A transportation problem to and from the sound room for testing made it necessary to exclude from the study patients 10 years of age and over who were non-ambulatory. All subjects, with the exception of known hearing loss subjects, were assumed to have normal hearing on the basis of the FFLV test administered earlier to the institution population.

Twenty subjects were originally assigned to each of six subgroups. Supervisors, nurses, and attendants of four cottages housing children 15 years of age and under were told the nature of the study and asked to choose children from their respective cottages for assignment to the first four subgroups (I, II, III, and IV). The project's secretary selected, on the basis of the project's and institution's records, 20 subjects to be placed in the two additional subgroups (V and VI). From the N of 20 subjects in each subgroup, five in each subgroup were randomly selected to be included in the study. Subgroups and a description of the criteria used for selection of subjects are given below. It can be seen from the criteria used that the selection of subjects for the first four subgroups was based primarily on the patient's gross behavior in the cottage.

Groups

I Easy to Test Group (ET)

II Brain Injured Group (BI)

III Severely Retarded Group (SR)

Criteria

High level children who give evidence of hearing ability in the cottage

Typified by hyperactivity, short attention span, but no or little other diagnostic indications (i.e., emotional disturbance)

Overall behavior of severe retardation

IV Emotionally Disturbed Group (ED)	Primary problem of emotional disturbance
V Randomly Selected Group (RS)	Randomly selected from institution population of children 15 years old and under
VI Hearing Loss Group (HL)	Children who failed the FFLV test and were diagnosed by an otologist as having possible neural sensory hearing loss, and/or children who had a history of auditory impairment

Equipment. The equipment utilized for this study consisted essentially of the same equipment used for the FFLV test (see page 24). The procedure section details the use of this apparatus.

Procedure. The same 10 voice or noise sounds utilized for the PALI test were taped at varying intensity levels and played back on the Ampex Tape Recorder until one was identified as plus or minus 1 db of the zero reference point on the panel intensity indicator. These sounds were randomized and spliced together with enough recording tape to make a constant 5 second interval between sounds. A copy of this tape was then recorded utilizing the Webcor Tape Recorder. Sounds were then re-randomized in the same manner and another copy re-recorded. A third copy was made following a third randomization of the sounds. All copies of the randomized order of sounds were played through the reproducing system into the sound room and found to be plus or minus 4 db of the zero reference point on a General Radio sound pressure level meter. This variation was accepted since it was found that minor alterations (such as varied placement of the crib) in the free field environment of the room produced similar changes. No attempt was made to control the frequency of the sounds, although an effort was made to include both high and low frequency sounds on the tapes. Therefore, the three recording tapes (Scotch

Magnetic Tape No. 131-12) utilized for the study consisted of the same 20 stimuli (five voice and five noise makers each repeated twice) randomized differently for each tape. A description of the sounds is presented in the form of a data sheet in Appendix N.

The subject was brought into the sound room described previously and seated in the center facing the operator of the panel. The operator always remained outside the room. Crib patients were placed in a crib at the center of the room. An effort was made to keep ambient noise level of the room as low as possible. In an attempt to minimize distractions, only necessary equipment (speakers in each corner, crib, three chairs, and a small table) was contained in the room.

After the subject was given time to adjust to his surroundings, the judge who remained in the room signaled the operator to start the test. The operator randomized the order of presenting the three tapes for each subject. The subject always received the first tape at a 30 db level, the second at 40 db, and the third at 60 db. The operator made an attempt to present each sound from a speaker directly behind the subject in order that responses to the sound might be easily detected. The operator regulated intensity of the sounds from the panel. Tapes were played at 7.5 inches per second during testing sessions.

Trained observers judged the subject's behavior during testing and scored it as a "response" or "no response" to each sound presented. Appendix N gives different types of behavior considered by the judges to be responses to sounds. Each subject was tested and judged twice using the same procedures. During the first test, only one judge evaluated the behavior of the subject. Both judges rated the subject's behavior during the second test. The two tests

were carried out on successive days.

Results and Discussion.

Data analysis included correlation of test-retest and inter-judge scores, and two analyses of variance of raw scores. Values utilized in the two analyses of variance were obtained by combining the three scores for each subject (scores given by the first judge during the first and second test and the score given by the second judge during the second test).

To establish test-retest reliability, a Pearson Product Moment Coefficient Correlation between total number of responses scored by the first judge during the first test and the total number of responses scored by the first judge during the second test was used. Inspection of Table 18 indicates that all r 's were sufficiently high to infer adequate test-retest reliability.

Table 19 presents Pearson r 's for the relationship between judges' evaluation of responses during the second test. As in the previous coefficient correlations, r 's were of a magnitude to give evidence of adequate inter-judge agreement. Due to these high reliabilities it was not considered necessary to employ either the first test and second test or the first judge and second judge scores as separate variables in an analysis of variance.

The first analysis of variance employed a Lindquist Type I Mixed Design (28) in which one of the factors corresponded to behavior classification (between groups) and the other to db condition (within groups). The results are summarized in Table 20. All F values were interpreted at the .05 level of significance.

Inspection of the analysis showed the behavior classification (between subjects) main effect and the db level (within subjects) main effect were significant at the .05 level of significance. Analysis of the partial main

Table 18

Test-Retest Reliability Coefficients of Number of Responses

(PALI-2) Test 1 and Test 2

(Pearson Product Moment Coefficients)

(N = 30)

db Level	r
20 db	.63
40 db	.69
60 db	.80
TOTAL (20, 40, and 60 db)	.78

$r \geq .35$ significant at .05 level

Table 19

Interjudge Reliability Coefficients of Number
of responses (FALL-7) Judge₁ and Judge₂ (N = 20)
(Pearson Product Moment Coefficients)

db Level	r
20 db	.58
40 db	.80
60 db	.72
TOTAL (20, 40, and 60 db)	.80

$r_{2.35}$ significant at .05 level

Table 20
Summary of Analysis of Variance of Number of Responses (PALI-2)
(Lindquist Type I)

Source	df	S ²	F
Between <u>Ss</u>	29	357.08	
B (behavior classification)	5	1311.56	8.29*
error (b)	24	158.23	
Within <u>Ss</u>	60	65.31	
A (db condition)	2	916.81	28.05*
AB	10	51.59	1.58
error (w)	48	32.69	
TOTAL	89		

*p. < .05

effects reported in Table 21 showed that the mean of the HL group was significantly less than that of all other subgroups. In addition, the ET group had a significantly greater number of responses than any of the other five subgroups. Partial main effects between db levels showed that subjects gave significantly fewer responses at the 20 db condition than either the 40 or 60 db condition and that subjects responded less at 40 db than at 60 db. The interaction was not significant. Hartley's Test of Homogeneity of Variance proved tenable.

The data were then entered into a Lindquist Type VI Mixed Design (28) analysis of variance with behavior classification as the between factor and db level and responses to voice and noise makers as the within factors. The results are summarized in Table 22.

The results of this analysis are similar to the Type I analysis described previously. In addition, it can be concluded from this analysis that subjects responded an equal number of times to both voice and noise makers. No interactions were significant. It should be noted for this analysis that while F values are interpreted at the .05 level of significance, the critical values were obtained by referring to the table of values for the .005 level. The procedure appeared advisable because of extreme variance. Lindquist (28), in 1953, on the basis of Norton's study recommends that allowances can be made for heterogeneity of variances by setting a higher level of significance for the tests of treatment effects than one would otherwise employ.

If this test were capable of discriminating between hearing loss mentally retarded subjects and non-hearing loss mentally retarded subjects, both main effects may be expected considering the presence of the known hearing loss group and the ET group.

Table 21
Group Means and SD's for Number of Responses by db Level (PA13-2)

Group	20 db		40 db		60 db		Total	
	N	SD	N	SD	N	SD	N	SD
I. Easy to Test	32.2	10.5	43.2	7.7	39.6	12.7	38.3	10.8
II. Brain Injured	22.2	10.4	23.2	7.7	31.8	6.3	25.7	8.9
III. Severely Retarded	14.0	5.4	26.4	12.9	32.4	7.5	24.3	11.7
IV. Emotionally Disturbed	21.0	1.9	28.8	6.0	34.0	9.2	27.9	8.1
V. Randomly Selected	24.0	4.9	28.2	11.7	36.0	9.5	29.6	9.9
VI. Hearing Loss	6.6	3.2	10.4	7.8	12.0	10.3	9.7	7.5
TOTAL	20.6	12.3	26.7	12.9	31.0	12.5	23.9	12.7

The three scores (test, retest, and interjudge) were used to obtain all of the scores indicated.

Table 22
Summary of Analysis of Variance of Number of Responses (PALI-2)
(Lindquist Type VI)

Source	df	S^2	F
Between $\underline{Ss}$	29		
C (behavior classification)	5	655.78	8.40*
error (b)	24	78.04	
Within $\underline{Ss}$	150		
A (db condition)	2	458.41	27.16*
B (voice, noise maker)	1	1.42	.11
AB	2	7.01	.67
AC	10	25.79	1.53
BC	5	19.13	1.47
ABC	10	9.75	.93
error (w)	120	13.57	
error ₁ (w)	48	16.88	
error ₂ (w)	24	13.03	
error ₃ (w)	48	10.53	
TOTAL	179		

*p. < .05 - Read from table at .005 level

One of the most striking results of the analysis was that the FALI-2 test did discriminate mentally retarded subjects with hearing losses from mentally retarded subjects with normal hearing regardless of their primary behavior classification. It was apparent that the FALI-2 test would have applicability for the discrimination of subjects with hearing loss from an identified population. The system of recording responses at the 20, 40, and 60 db levels, although useful as an indicator of level of loss, did not appear essential in applying the test procedure to screening purposes. The use of 20 sounds at each intensity level resulted in adequate test-retest reliability.

SECTION V
CONCLUSIONS AND IMPLICATIONS

CONCLUSIONS AND IMPLICATIONS

Several approaches were used to investigate the problems posed by this study. The three major aims; determination of the incidence of hearing loss in this population, the evaluation of available tests, and the development of new hearing test procedures were extensively explored.

Incidence.

The incidence of hearing loss, as measured by the number of patients who failed standard pure tone audiometric testing (of those testable by this procedure) was 25 per cent. Incidence as measured by those who failed the FFLV screening was 24 per cent. While these two figures appear to be nearly identical, the first (pure tone) represents the results of tests administered to only 30 per cent of the total population. On the other hand, while the incidence reported for FFLV represents the results of tests administered to the total available population, it involved a much less discriminating test.

From the results of this and other reported research, it appears that the concept "incidence of hearing loss" can have little meaning outside of each particular study. Comparisons with so-called normal populations would appear to be inappropriate due to the inability of such a large percentage of this population to respond to standard techniques. Incidence of hearing loss with a mentally retarded population, in respect to the detection of responses, seems to be greatly dependent upon the type of testing procedure utilized and the kinds of responses required.

A further conclusion of this study was that the patients identified with suspected hearing loss had a high rate of ear pathology; nearly one-half of those screened out. The recognition of such problems in this population may

be as difficult as the assessment of hearing loss.

Psychologically, the patients with suspected hearing loss were seen as severely retarded in all areas. They appeared to have great difficulty in comprehension and to make few attempts in communication as well. Developmentally, mention of an auditory problem in the patient's file was found in one-third of the instances. A similar frequency was found for mention of a visual problem in these patient's files. Severe developmental delay was observed in the group referred. The interpretation of the results of the psychological testing with this patient population was that the currently available psychological tests are not adequate. This was particularly true in the younger age group used in this investigation.

Evaluation of Available Hearing Tests.

The second major goal, the evaluation of available tests, was dealt with through the use of pilot groupings. The results indicated that the majority of such tests were not statistically or clinically useful with this population. Of the tests currently available only two were found to be useful for screening purposes. These were the standard pure tone and free field, live voice, sound awareness procedures (FFLV). The first, pure tone, appeared to be useful only when subjects were initially selected as being able to respond to this test. The second, required considerable modification in order to adequately utilize it as a test procedure.

The use of a battery of test procedures, which according to the results of this investigation, have little statistical utility in their application to this population is open to question. Since the major purpose of such a battery would be to measure multiple facets of hearing to obtain improved identification of hearing loss, it does not appear to be a practical procedure.

The ability to meaningfully interpret sound is so frequently lacking in this patient population that discrimination of subjects with a hearing loss and without a hearing loss on this basis would result in an unrealistically high incidence of loss. A further point is that only testing of awareness of sound appeared to have adequate utility. This definition, "awareness of sound", appears to be the appropriate basis for hearing test procedures with this population. The frequently occurring recommendation in the literature to utilize a battery of tests with patients in this population probably needs to be revised as a result of the foregoing conclusions.

If the purpose of a battery of procedures is to enable the tester to selectively employ tests where applicable in view of the subject's behavior, mental age, other physical handicaps, etc., the use of a battery of tests could be more defensibly approved. Such test selection, however, is not easily applicable in broad scale testing programs since it is assumed that several such procedures might have to be tried before a successful one would be found. This study also pointed out, that for this population, the frequency of success of adequate testing for the vast majority of tests was extremely low.

Another point might be made in regard to the suggestion to select the lowest threshold obtained from multiple test administration. While such a selection potentially would lower the incidence of hearing loss, this procedure must face several serious criticisms. Among these are: (1) only one test procedure appeared sufficiently statistically valuable with a majority of the population. The addition of other test procedures with unreliability, lack of discrimination, and serious questions as to their reproducibility may preclude adequate measurement. (2) The lack of adequate measurement in tests

on this population brings into serious question the use of the lowest obtained threshold as a valid estimate of hearing. It would be expected that if enough tests with low precision of measurement were administered, nearly every patient would pass a screening level of 20 db on one of the tests. This might even be true of students in a school for the deaf if the standard error of measurement of the procedures was as great as the application of currently used hearing test procedures on the population studied in this investigation.

Perhaps the most important aspect of this study is to bring into serious question hearing test procedures, as modified and intended to be similar to those previously defined by other investigators, when applied to retarded patients. Multiple test administration does not appear to be advisable unless the tests added are adequately evaluated on the population to be tested in terms of test-retest, inter-judge reliability, and ability to discriminate hard of hearing subjects from behavioral categories with similar observed behavior characteristics.

Replication of the Polysound Auditory Level Index - 2 (PALI-2) test, developed in this project, appears to be a better choice where improved measurement precision is desired. Multiple administration of this test, measuring awareness of sound, would result in an obtained average which would make the standard error of measurement small and permit adequate definition of the hearing status of an individual.

Developed Hearing Tests.

EER-Audio testing, while unreliable from test to retest as used in this study, appeared potentially capable of development. Reliability improvement could be resolved by more presentations, a longer test, or multiple test administrations. The lack of observable responses to sound at near-threshold levels (20 db), however, appeared to eliminate this procedure as a screening

device. Further investigation of EER-Audio did appear warranted in regard to its use as a diagnostic tool. Such investigation should possibly explore the relationship between EER-Audio testing, other hearing test procedures, and the outcomes of training.

The PALI-2 test procedure developed under this project discriminated between a group of subjects previously identified as having hearing loss by other sources and between other diagnostic groupings with similar behavioral responses. It seems likely that this test procedure, or a further development of it along similar lines, should be applied to this population on a broad scale. Improved hearing testing of young, mentally retarded, institutionalized patients would then appear possible. It should be kept in mind that the scores from the PALI-2 test are based on relatively few subjects, and resulted only when judges accepted any behavioral change as a response to sound. This qualifying variable points to the necessity to obtain information as to the way judges score behavior under this test situation and, in effect, to set up normative data for each judge involved. The procedure of testing subjects whose diagnosis is unknown to the judge but who are severely retarded, disturbed, brain injured, and hard of hearing to establish normative data on judgements obtained seems essential prior to attempts at delineating the situation for individual patients whose hearing status is unknown.

The major point here is that many of the test procedures as evaluated in this project do not appear to result in valid estimates of hearing ability when applied to this population. The procedure recommended, although statistically useful in this study, appeared capable of similar error unless the discrimination ability and extent of judge error is previously determined on a known population.

APPENDICES

Appendix A

Speech Test

Tester _____ Testing Order _____ Name _____
Evaluator _____ Date _____ Age _____
Assistant _____ Time In _____ Sex _____
Time Out _____ Cottage Number _____

Adjustment to testing environment immediate _____ time failed
(minute maximum) Comments _____

Acceptance of B.C. oscillator immediate _____ time failed
(minute maximum) Comments _____

Input: Live Voice

Output: Speaker B.C.
One Right Ear
Two Left Ear
Three Other _____
Four _____

Material Used:

Pictures _____

Body Parts _____

Comprehension of instructions and materials immediate _____ time
failed (minute maximum) Comments _____

Behavior during test procedures apprehensive restless cooperative
inactive other Comments _____

Efficacy of test 0 1 2 3 4 5 6
Very Low Very High

Comments _____

Conclusions _____

	1	2	3	4	TOTAL CORRECT
+10	Leg	Eyes	Arm	Hair	
+ 5	Neck	Neck	Hair	Nose	
0	Mouth	Nose	Arm	Leg	
- 5	Shoe	Hand	Ear	Nose	
-10	Hand	Hair	Nose	Neck	

KEY Correct +
 Incorrect -
 No Response 0

	1	2	3	TOTAL CORRECT
+10				
+ 5				
0				
- 5				
-10				

COMMANDS

Free Field	Air L.E.	Air R.E.	B.C. L.E.	B.C. R.E.
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

PICTURES

Free Field	Air L.E.	Air R.E.	B.C. L.E.	B.C. R.E.
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

0 - Not Administered -
 1 - - - 20 db - - -
 2 - - 25 to 30 db - -
 3 - - 35 to 40 db - -
 4 - - 45 to 50 db - -
 5 - - 55 to 60 db - -
 6 - - 65 to 70 db - -
 7 - - 75 to 80 db - -
 8 - - 85 to 90 db - -
 9 - - 95 to 100 db - -

SOUND LOCALIZATION

Tester _____ Testing Order _____ Name _____
 Evaluator _____ Date _____ Age _____
 Assistant _____ Time In _____ Sex _____
 Time Out _____ Cottage No. _____

Adjustment to testing environment immediate _____ time failed
 (_____ minute maximum) Comments _____

Behavior during test procedures apprehensive restless cooperative
 inattentive other Comments _____

Stimuli	10	20	30	40	50	60	70	80	90	100	Comments
Name											
Command											
Question											
Greeting											
Whistle											
Tongue Click											
Column #	0	1	2	3	4	5	6	7	8	9	X

Did Not Administer

No Response

Comments _____

Conclusions _____

P.G.S.R.

Tester _____ Testing Order _____ Name _____
 Evaluator _____ Date _____ Age _____
 Assistant _____ Time In _____ Sex _____
 Time Out _____ Cottage No. _____

Adjustment to testing environment immediate time failed
 (_____ minute maximum)

Acceptance of headphones immediate time _____ failed
 (_____ minute maximum)

Placement of electrodes Skin _____ Shock _____

Measurement of Resistance _____

Intensity of Shock _____ Length of Shock _____

Length of tone _____ Interval between stimuli _____

Input _____ Output _____

Behavior during test procedures apprehensive restless cooperative
 inactive other Comments _____

RESULTS TO TEST

	1000		4000		Voice No Shock	Noise No Shock
	LE	RE	LE	RE		
X - would not tolerate PGSR apparatus	X	X	X	X	X	X
Y - no satisfactory results	Y	Y	Y	Y	Y	Y
0 - did not administer	0	0	0	0	0	0
1 - 20 db	1	1	1	1	1	1
2 - 25-30 db	2	2	2	2	2	2
3 - 35-40 db	3	3	3	3	3	3
4 - 45-50 db	4	4	4	4	4	4
5 - 55-60 db	5	5	5	5	5	5
6 - 65-70 db	6	6	6	6	6	6
7 - 75-80 db	7	7	7	7	7	7
8 - 85-90 db	8	8	8	8	8	8
9 - 90 db-up	9	9	9	9	9	9

Comments _____

Conclusions _____

AUDIOMETRIC RECORD

Name _____ Age _____ Sex _____ Cottage Number _____
 Date _____ Audiometer _____ Examiner _____ Validity _____

PURE TONE

	125	250	500	1000	2000	4000	8000	
-10								-10
0								0
10			LE RE	LE RE	LE RE	LE RE		10
20	Not Administered		0 0	0 0	0 0	0 0		20
30			1 1	1 1	1 1	1 1		30
40			2 2	2 2	2 2	2 2		40
50			3 3	3 3	3 3	3 3		50
60			4 4	4 4	4 4	4 4		60
70			5 5	5 5	5 5	5 5		70
80			6 6	6 6	6 6	6 6		80
90			7 7	7 7	7 7	7 7		90
100			8 8	8 8	8 8	8 8		100
			9 9	9 9	9 9	9 9		
			10 10	10 10	10 10	10 10		
			11 11	11 11	11 11	11 11		
			12 12	12 12	12 12	12 12		
			13 13	13 13	13 13	13 13		
			14 14	14 14	14 14	14 14		
			15 15	15 15	15 15	15 15		
			16 16	16 16	16 16	16 16		
			17 17	17 17	17 17	17 17		
			18 18	18 18	18 18	18 18		

No Response 18 18 18 18 18 18 18 18

Pure Tone Indicator 0 - not administered 1 - passed 2 - failed

BONE CONDUCTION

	500	1000	2000	4000
	L.E. R.E.	L.E. R.E.	L.E. R.E.	L.E. R.E.
0 - not administered - - - -	0 0	0 0	0 0	0 0
1 - same as air conduction -	1 1	1 1	1 1	1 1
2 - 5 to 10 db better - - -	2 2	2 2	2 2	2 2
3 - 15 to 20 db better - - -	3 3	3 3	3 3	3 3
4 - 25 to 30 db better - - -	4 4	4 4	4 4	4 4
5 - 35 to 40 db better - - -	5 5	5 5	5 5	5 5
6 - 45 to 50 db better - - -	6 6	6 6	6 6	6 6
7 - 55 to 60 db better - - -	7 7	7 7	7 7	7 7
8 - 65 db and up - - - - -	8 8	8 8	8 8	8 8
9 - No Response - - - - -	9 9	9 9	9 9	9 9

MASKING

Left Ear 0 - Not administered 1 - Administered
 Right Ear 0 - Not administered 1 - Administered

Appendix B

Picture Identification Test Development

As a result of the standardization process reported in Section II, it was hypothesized that the pictures utilized in the Picture Identification Test developed by Siegenthaler, et al. (43) would be unfamiliar to a large number of the population involved in this study. It was believed that the limited environmental exposure experienced by a large segment of an institutional population would severely restrict the range of objects recognizable. An attempt was made, therefore, to develop a series of pictures which would be most readily recognized by the largest number of patients.

The attendants and supervisors in each of the ten patient cottages within the institution were asked to contribute lists of objects which they felt would be familiar to most of the patients assigned to their care. A total of 55 items were collected by this means. Colored pictures representing these objects were gathered along with 55 pictures representing all of the items (less the duplications) on both forms of the Siegenthaler test. Groups of two pictures were mounted on 8½" x 11" plain white notebook paper and placed in a looseleaf binder. These pictures were then presented to 50 randomly selected children, under 20 years of age, within the institution and scored for correct responses. Items receiving less than 50 per cent responses were excluded. This procedure resulted in the elimination of all except 60 items which, interestingly, included only five pictures which were not listed on the Siegenthaler test.

These 60 pictures were presented in two randomized orders to a group of 32 patients, under the age of 10, who had been randomly selected from the population. The final group of pictures (listed below) were arbitrarily selected from those that received the greatest number of responses in the above

procedure.

Bird*	Glass*	Boat*	Milk	Socks
Cake	Hat	Clock	Tree	Dog
Gun	Horse	Truck	Clown	Bed (Crib)
Cracker*	Blocks	Doll	Shoe	Spoon
Pie	Eyes	Nurse*	Man (Doctor)	Ball
Car	Comb			

The asterisks indicate those pictures which differed from the original test. The words followed by parenthetical items represent the changes necessary to elicit responses; such as replacing the picture of a man in a business suit with the picture of a man in the white apparel worn by a doctor.

The results of this preliminary study were almost completely negative to the original hypothesis. Apparently television and the wide variety of toys available today compensate to some degree for the restricted environment of an institution for the mentally retarded.

Appendix C

Social Work Evaluation Instrument

Name _____

IBM Columns	Number	Code	
1	1 2 3 4 5 6 7 8 9 0		Institutional Identification Number
2	1 2 3 4 5 6 7 8 9 0		
3	1 2 3 4 5 6 7 8 9 0		
4	1 2 3 4 5 6 7 8 9 0		
5	1 2 3 4 5 6 7 8 9 0		Birthdate
6	1 2 3 4 5 6 7 8 9 0		
7	1 2 3 4 5 6 7 8 9 0		Columns 5-6 = month
8	1 2 3 4 5 6 7 8 9 0		Columns 7-8 = day
9	1 2 3 4 5 6 7 8 9 0		Columns 9-10 = year
10	1 2 3 4 5 6 7 8 9 0		
11	0 Male 1 Female		Sex
12	0 White 1 Negro 2 Oriental 3 American Indian		Color or Race
13	Etiological Classification A.A.M.D.		
	0 Undifferentiated - none specific - deferred		
	1 Associated with diseases and conditions due to infection		
	2 Associated with diseases and conditions due to cerebral damage due to serum, drugs, or other toxic agents		
	3 Associated with diseases and conditions due to trauma or physical agent		
	4 Associated with diseases and conditions due to disorder of metabolism, growth, or nutrition		
	5 Associated with diseases and conditions due to new growths		
	6 Associated with diseases and conditions due to unknown prenatal influence		
	7 Associated with diseases and conditions due to unknown or uncertain cause with structural reactions manifest		
	8 Due to uncertain or presumed psychologic cause with the functional reaction alone manifest		
14	1 2 3 4 5 6 7 8 9 0		Date Admitted to a State Institution
15	1 2 3 4 5 6 7 8 9 0		
16	1 2 3 4 5 6 7 8 9 0		Columns 14-15 = month
17	1 2 3 4 5 6 7 8 9 0		Columns 16-17 = day
18	1 2 3 4 5 6 7 8 9 0		Columns 18-19 = year
19	1 2 3 4 5 6 7 8 9 0		

20 1 2 3 4 5 6 7 8 9 0 Age
21 1 2 3 4 5 6 7 8 9 0

22 Abnormal Conditions of Mother During Pregnancy

- 0 None said to have existed
- 1 Toxemia
- 2 Rubella during first trimester
- 3 Rh factor
- 4 Hemorrhage
- 5 Syphilis
- 6 Other
- 9 Information not available

23 Age of Mother at Time Child was Born

- 0 Under 21
- 1 21-25
- 2 26-30
- 3 31-35
- 4 36-40
- 5 Over 40
- 9 Information not available

24 Age of Father at Time Child was Born

- 0 Under 21
- 1 21-25
- 2 26-30
- 3 31-35
- 4 36-40
- 5 Over 40
- 9 Information not available

25 Weight of Child at Birth

- 0 2-2'15
- 1 3-3'15
- 2 4-4'15
- 3 5-5'15
- 4 6-6'15
- 5 7-7'15
- 6 8-8'15
- 7 9-9'15
- 8 Over 10
- 9 Information not available

26 Length of Pregnancy

- 0 Full term
- 1 Premature
- 2 Postmature
- 9 Information not available

- 27 Birth was
- 0 Cephalic
 - 1 Breech
 - 2 Caesarian
 - 9 Information not available
- 28 At Birth Instruments
- 0 Were used
 - 1 Were not used
 - 9 Information not available
- 29 Abnormalities of Labor
- 0 None
 - 1 Prolonged
 - 2 Precipitate
 - 9 None recorded
- 30 Abnormal Conditions of Child at Birth or Neonatal State
- 0 None
 - 1 Cyanosis
 - 2 Convulsions
 - 3 Anoxia
 - 4 Jaundice
 - 5 Mongoloid features noted
 - 6 Other
 - 9 Information not available
- 31 Age Child First Sat Without Support
- 0 Under 6 months
 - 1 6-7 months
 - 2 8-9 months
 - 3 10-12 months
 - 4 13-18 months
 - 5 19-24 months
 - 6 25-36 months
 - 7 Over 36 months
 - 8 Child cannot sit alone
 - 9 Information not available
- 32 Age Child First Walked Alone
- 0 Under 12 months
 - 1 12-18 months
 - 2 19-24 months
 - 3 25-36 months
 - 4 37-48 months
 - 5 49-60 months
 - 6 61-72 months
 - 7 Over 6 years
 - 8 Cannot walk
 - 9 Information not available

33 Age Child Said First Word

- 0 Under 12 months
- 1 12-18 months
- 2 19-24 months
- 3 25-36 months
- 4 37-48 months
- 5 49-60 months
- 6 61-72 months
- 7 Over 6 years
- 8 Cannot say words
- 9 Information not available

34 Age Child was Weaned

- 0 Under 10 months
- 1 10-12 months
- 2 13-15 months
- 3 16-18 months
- 4 19-21 months
- 5 22-24 months
- 6 25-27 months
- 7 Over 27 months
- 8 Not yet weaned
- 9 Information not available

35 Age Child Completed Toilet Training

- 0 Under 18 months
- 1 19-24 months
- 2 25-30 months
- 3 31-36 months
- 4 37-48 months
- 5 49-60 months
- 6 61-72 months
- 7 Over 6 years
- 8 Not yet toilet trained
- 9 Information not available

36 Age at Which Child was Separated from Mother or Mother Substitute

- 0 Less than 3 months
- 1 4-6 months
- 2 7-9 months
- 3 10-12 months
- 4 13-18 months
- 5 19-24 months
- 6 2-4 years
- 7 5-7 years
- 8 8-10 years
- 9 Over 10 years

- 37 Home Situation
- 0 Family group intact, giving some care to patient
 - 1 Family group intact but unable to give any care
 - 2 Family group broken through death, separation, etc.
 - 3 Family group never existed
 - 4 Siblings continue care to patient
- 38 History of Retardation in Family
- 0 No
 - 1 Yes
 - 9 Information not available
- 39 History of Psychiatric Deviation in Family
- 0 No
 - 1 Yes
 - 9 Information not available
- 40 Child has had Convulsions Other Than Febrile
- 0 No
 - 1 Yes
 - 9 Information not available
- 41 History of Visual Impairment Suggested in Record
- 0 No
 - 1 Yes
 - 9 Information not available
- 42 History of Auditory Impairment Suggested in Record
- 0 No
 - 1 Yes
 - 9 Information not available
- 43 History of Severe Economic Deprivation Indicated in Record
- 0 No
 - 1 Yes
 - 9 Information not available
- 44 Condition Defined and Referral for Institutionalization Recommended By
- 0 Family Physician
 - 1 Pediatrician
 - 2 Neurologist
 - 3 Psychiatrist
 - 4 Social Agency
 - 5 Obstetrician
 - 6 Clinical Psychologist
 - 7 Osteopath
 - 8 Physician

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Condition Defined and Referral for Institutionalization Also Recommended By

- 0 Family physician
- 1 Pediatrician
- 2 Neurologist
- 3 Psychiatrist
- 4 Social Agency
- 5 Obstetrician
- 6 Clinical psychologist
- 7 Osteopath
- 8 Physician

1. ...	0
2. ...	1
3. ...	2
4. ...	3
5. ...	4
6. ...	5
7. ...	6
8. ...	7
9. ...	8
10. ...	0
11. ...	1
12. ...	2
13. ...	3
14. ...	4
15. ...	5
16. ...	6
17. ...	7
18. ...	8
19. ...	0
20. ...	1
21. ...	2
22. ...	3
23. ...	4
24. ...	5
25. ...	6
26. ...	7
27. ...	8
28. ...	0
29. ...	1
30. ...	2
31. ...	3
32. ...	4
33. ...	5
34. ...	6
35. ...	7
36. ...	8
37. ...	0
38. ...	1
39. ...	2
40. ...	3
41. ...	4
42. ...	5
43. ...	6
44. ...	7
45. ...	8
46. ...	0
47. ...	1
48. ...	2
49. ...	3
50. ...	4
51. ...	5
52. ...	6
53. ...	7
54. ...	8
55. ...	0
56. ...	1
57. ...	2
58. ...	3
59. ...	4
60. ...	5
61. ...	6
62. ...	7
63. ...	8
64. ...	0
65. ...	1
66. ...	2
67. ...	3
68. ...	4
69. ...	5
70. ...	6
71. ...	7
72. ...	8
73. ...	0
74. ...	1
75. ...	2
76. ...	3
77. ...	4
78. ...	5
79. ...	6
80. ...	7
81. ...	8
82. ...	0
83. ...	1
84. ...	2
85. ...	3
86. ...	4
87. ...	5
88. ...	6
89. ...	7
90. ...	8
91. ...	0
92. ...	1
93. ...	2
94. ...	3
95. ...	4
96. ...	5
97. ...	6
98. ...	7
99. ...	8

Appendix D

Social Work Evaluation Breakdown by Item

<u>Frequency</u>	<u>Item</u>
60	1. Male
33	Female
89	2. White
4	Negro
0	Oriental
0	American Indian
	3. Etiological Classification
7	Undifferentiated - none specific - deferred
5	Associated with diseases and conditions due to infection
1	Associated with diseases and conditions due to cerebral damage due to serum, drugs, or other toxic agents
6	Associated with diseases and conditions due to trauma or physical agent
3	Associated with diseases and conditions due to disorder of metabolism, growth, or nutrition
0	Associated with diseases and conditions due to new growths
51	Associated with diseases and conditions due to unknown prenatal influence
6	Associated with diseases and conditions due to unknown or uncertain cause with structural reactions manifest
14	Due to uncertain or presumed psychologic cause with the functional reaction alone manifest
	4. Abnormal Conditions of Mother During Pregnancy
47	None said to have existed
1	Toxemia
2	Rubella during first trimester
0	Rh factor
4	Hemorrhage
0	Syphilis
16	Other
23	Information not available
	5. Age of Mother at Time Child was Born
17	Under 21
30	21-25
17	26-30
12	31-35
10	36-40
5	Over 40
2	Information not available

<u>Frequency</u>	<u>Item</u>
	6. Age of Father at Time Child was Born
5	Under 21
23	21-25
16	26-30
16	31-35
12	36-40
15	Over 40
6	Information not available
	7. Weight of Child at Birth
3	2-2'15
3	3-3'15
6	4-4'15
12	5-5'15
26	6-6'15
20	7-7'15
12	8-8'15
5	9-9'15
1	10 or over
5	Information not available
	8. Length of Pregnancy
66	Full term
15	Premature
1	Postmature
9	Information not available
	9. Birth was
62	Cephalic
4	Breech
0	Caesarian
27	Information not available
	10. At Birth Instruments
14	Were used
43	Were not used
36	Information not available
	11. Abnormalities of Labor
46	None
6	Prolonged
2	Precipitate
39	None recorded

<u>Frequency</u>	<u>Item</u>
	12. Abnormal Conditions of Child at Birth or Neonatal State
27	None
10	Cyanosis
1	Convulsions
2	Anoxia
0	Jaundice
13	Mongoloid features noted
11	Other
29	Information not available
	13. Age Child First Sat Without Support
0	Under 6 months
2	6-7 months
4	8-9 months
14	10-12 months
12	13-18 months
8	19-24 months
2	25-36 months
3	Over 36 months
3	Child cannot sit alone
43	Information not available
	14. Age Child First Walked Alone
0	Under 12 months
13	12-18 months
8	19-24 months
13	25-36 months
13	37-48 months
5	49-60 months
3	61-72 months
0	Over 6 years
8	Cannot walk
30	Information not available
	15. Age Child Said First Word
0	Under 12 months
3	12-18 months
5	19-24 months
6	25-36 months
5	37-48 months
2	49-60 months
2	61-72 months
1	Over 6 years
15	Cannot say words
54	Information not available

<u>Frequency</u>	<u>Item</u>
	16. Age Child was Weaned
5	Under 10 months
6	10-12 months
5	13-15 months
3	16-18 months
1	19-21 months
5	22-24 months
0	25-27 months
6	Over 27 months
2	Not yet weaned
60	Information not available
	17. Age Child Completed Toilet Training
2	Under 18 months
1	19-24 months
2	25-30 months
3	31-36 months
0	37-48 months
1	49-60 months
3	61-72 months
5	Over 6 years
19	Not yet toilet trained
57	Information not available
	18. Age at Which Child was Separated from Mother or Mother Substitute
7	Less than 3 months
2	4-6 months
1	7-9 months
6	10-12 months
7	13-18 months
4	19-24 months
18	2-4 years
18	5-7 years
10	8-10 years
20	Over 10 years
	19. Home Situation
55	Family group intact, giving some care to patient
3	Family group intact but unable to give any care
20	Family group broken through death, separation, etc.
6	Family group never existed
9	Siblings continue care to patient
	20. History of Retardation in Family
64	No
22	Yes
7	Information not available

<u>Frequency</u>	<u>Item</u>
	21. History of Psychiatric Deviation in Family
61	No
23	Yes
9	Information not available
	22. Child has had Convulsions Other Than Febrile
66	No
26	Yes
1	Information not available
	23. History of Visual Impairment Suggested in Record
69	No
24	Yes
0	Information not available
	24. History of Auditory Impairment Suggested in Record
63	No
30	Yes
0	Information not available
	25. History of Severe Economic Deprivation Indicated in Record
73	No
18	Yes
2	Information not available
	26. Condition Defined and Referral for Institutionalization Recommended by
40	Family physician
8	Pediatrician
2	Neurologist
0	Psychiatrist
2	Social Agency
0	Obstetrician
3	Clinical psychologist
1	Osteopath
37	Physician
	27. Condition Defined and Referral for Institutionalization Also Recommended by
0	Family physician
24	Pediatrician
1	Neurologist
1	Psychiatrist
3	Social Agency
2	Obstetrician
1	Clinical psychologist
1	Osteopath
60	Physician

Appendix E

Psychological Report

Patient's Name _____

IBM
Columns

Number Code

1	1 2 3 4 5 6 7 8 9 0
2	1 2 3 4 5 6 7 8 9 0
3	1 2 3 4 5 6 7 8 9 0
4	1 2 3 4 5 6 7 8 9 0
5	1 2 3 4 5 6 7 8 9 0
6	1 2 3 4 5 6 7 8 9 0
7	1 2 3 4 5 6 7 8 9 0
8	1 2 3 4 5 6 7 8 9 0
9	1 2 3 4 5 6 7 8 9 0
10	1 2 3 4 5 6 7 8 9 0
11	1 2 3 4 5 6 7 8 9 0
12	1 2 3 4 5 6 7 8 9 0
13	1 2 3 4 5 6 7 8 9 0
14	1 2 3 4 5 6 7 8 9 0

Institutional Identification Number

Birthdate

Columns 5-6 = month
Columns 7-8 = day
Columns 9-10 = year

C.A. at Date of Testing

11-12 = year
13-14 = month

15 Cattell Infant Intelligence Scale Mental Age

- 0 Not administered
- 1 Below 6 months
- 2 6 months - 12 months
- 3 1.1 year to 2.0 year
- 4 2.1 year to 3.0 year
- 5 3.1 year to 4.0 year
- 6 4.1 year to 5.0 year
- 7 5.1 year to 6.0 year
- 8 Over 6 years
- 9 Unable to determine

16 Cattell Infant Intelligence Scale I.Q.

- 0 Not administered
- 1 Below 5
- 2 6-15
- 3 16-25
- 4 26-35
- 5 36-45
- 6 46-55
- 7 56-65
- 8 Over 65
- 9 Unable to determine

17 Gesell Developmental Schedule Motor Age

- 0 Not administered
- 1 Below 12 weeks
- 2 12 weeks - 28 weeks
- 3 29 weeks - 40 weeks
- 4 41 weeks - 52 weeks
- 5 13 months - 18 months
- 6 19 months - 24 months
- 7 25 months - 36 months
- 8 Over 36 months
- 9 Unable to determine

18 Gesell Developmental Schedule Adaptive Age

- 0 Not administered
- 1 Below 12 weeks
- 2 12 weeks - 28 weeks
- 3 29 weeks - 40 weeks
- 4 41 weeks - 52 weeks
- 5 13 months - 18 months
- 6 19 months - 24 months
- 7 25 months - 36 months
- 8 Over 36 months
- 9 Unable to determine

19 Gesell Developmental Schedule Language Age

- 0 Not administered
- 1 Below 12 weeks
- 2 12 weeks - 28 weeks
- 3 29 weeks - 40 weeks
- 4 41 weeks - 52 weeks
- 5 13 months - 18 months
- 6 19 months - 24 months
- 7 25 months - 36 months
- 8 Over 36 months
- 9 Unable to determine

20 Gesell Developmental Schedule Personal-Social Age

- 0 Not administered
- 1 Below 12 weeks
- 2 12 weeks - 28 weeks
- 3 29 weeks - 40 weeks
- 4 41 weeks - 52 weeks
- 5 13 months - 18 months
- 6 19 months - 24 months
- 7 25 months - 36 months
- 8 Over 36 months
- 9 Unable to determine

21 Leiter International Performance Mental Age

- 0 Not administered
- 1 Below 4 years
- 2 4.1 year - 5.0 year
- 3 5.1 year - 6.0 year
- 4 6.1 year - 7.0 year
- 5 7.1 year - 8.0 year
- 6 8.1 year - 9.0 year
- 7 9.1 year - 10.0 year
- 8 Over 10 years
- 9 Unable to determine

22 Leiter International Performance I.Q.

- 0 Not administered
- 1 Below 20
- 2 21-30
- 3 31-40
- 4 41-50
- 5 51-60
- 6 61-70
- 7 71-80
- 8 Over 80
- 9 Unable to determine

23 Nebraska (Hiskey) Learning Aptitude Mental Age

- 0 Not administered
- 1 Below 4 years
- 2 4.1 year - 5.0 year
- 3 5.1 year - 6.0 year
- 4 6.1 year - 7.0 year
- 5 7.1 year - 8.0 year
- 6 8.1 year - 9.0 year
- 7 9.1 year - 10.0 year
- 8 Over 10 years
- 9 Unable to determine

24 Nebraska (Hiskey) Learning Aptitude I.Q.

- 0 Not administered
- 1 Below 20
- 2 21-30
- 3 31-40
- 4 41-50
- 5 51-60
- 6 61-70
- 7 71-80
- 8 Over 80
- 9 Unable to determine

25 Vineland Social Maturity Scale Age Equivalent

- 0 Not administered
- 1 Below 6 months
- 2 6 months - 12 months
- 3 1.1 year - 2.0 year
- 4 2.1 year - 4.0 year
- 5 4.1 year - 6.0 year
- 6 6.1 year - 8.0 year
- 7 8.1 year - 10.0 year
- 8 Over 10 years
- 9 Unable to determine

26 Vineland Social Maturity Scale S.Q.

- 0 Not administered
- 1 Below 11
- 2 11-25
- 3 26-35
- 4 36-50
- 5 51-60
- 6 61-70
- 7 71-80
- 8 Over 80
- 9 Unable to determine

27 Peabody Picture Identification Test Mental Age

- 0 Not administered
- 1 Below 4 years
- 2 4.1 years - 5.0 years
- 3 5.1 years - 6.0 years
- 4 6.1 years - 7.0 years
- 5 7.1 years - 8.0 years
- 6 8.1 years - 9.0 years
- 7 9.1 years - 10.0 years
- 8 Over 10 years
- 9 Unable to determine

28 Peabody Picture Identification Test I.Q.

- 0 Not administered
- 1 Below 20
- 2 21-30
- 3 31-40
- 4 41-50
- 5 51-60
- 6 61-70
- 7 71-80
- 8 Over 80
- 9 Unable to determine

- 29 **Intelligence Quotient**
- 0 Not testable by standardized tests
 - 1 Below 20 (profound)
 - 2 21-35 (severe)
 - 3 36-51 (moderate)
 - 4 52-69 (mild)
 - 5 70-84 (borderline)
 - 6 85 and above
- 30 **Estimated Potential I.Q.**
- 0 Unable to estimate
 - 1 Same as tested
 - 2 Higher than tested
- 31 **Social Quotient**
- 0 Unable to determine
 - 1 0-10 (low idiot level)
 - 2 11-25 (higher idiot level)
 - 3 26-35 (low imbecile level)
 - 4 36-50 (higher imbecile level)
 - 5 51-60 (low moron level)
 - 6 61-70 (higher moron level)
 - 7 Above 70
- 32 **Attention Span**
- 0 Unable to determine
 - 1 Extremely short - flits from one thing to another
 - 2 Short - difficult to hold to a task
 - 3 Average - able to focus attention for duration of task, can maintain attention and yet shift to the next
 - 4 Prolonged - cannot make transition from one task to another
- 33 **Motoric Activity**
- 0 Unable to determine
 - 1 Severely hypoactive - just lies or sits
 - 2 Moderately hypoactive - up and locomoting
 - 3 Average - purposeful activity
 - 4 Moderately hyperactive - fidgety and restless
 - 5 Severely hyperactive - moving about almost constantly
- 34 **Perseveration**
- 0 Unable to determine
 - 1 None
 - 2 Mild
 - 3 Severe

- 35 **Reaction to New Situation**
- 0 Unable to determine
 - 1 Withdraws - reluctant, anxious
 - 2 Neutral - unaffected
 - 3 Approaches - unafraid
- 36 **Degree of Dependency (Child's Request for Help)**
- 0 Unable to determine
 - 1 Autonomus functioning - does not feel a need for others
 - 2 Makes continuing efforts unaided when beyond his capacity (unhealthy)
 - 3 Realistic interdependence - seeks help when needs it (healthy)
 - 4 Dependence - seeks help beyond actual need
- 37 **Stereotypy - degree to which child insists on rigidly set routines or patterns in daily living**
- 0 Unable to determine
 - 1 None
 - 2 Little
 - 3 Much
- 38 **Ability to Postpone Gratification**
- 0 Unable to determine
 - 1 Can be counted on to delay satisfaction if expected to do so
 - 2 Generally can be expected to wait for rewards if encouraged to do so, sometimes wants immediate satisfaction
 - 3 Generally wants things here and now, impatient about delays, can sometimes wait if encouraged
 - 4 Shows marked inability to postpone present satisfaction for future reward
- 39 **Response to Sound**
- 0 Unable to determine
 - 1 None
 - 2 Questionable
 - 3 Definite response to sound
- 40 **Degree of Cooperativeness**
- 0 Unable to determine
 - 1 Cooperative
 - 2 Uncooperative
 - 3 Average
 - 4 Eager
- 41 **Compensatory Use of Senses**
- 0 Unable to determine
 - 1 Yes
 - 2 No

- 42 **Fear**
- 0 Unable to determine
 - 1 Minimal
 - 2 Expected amount
 - 3 Predominate behavior
- 43 **Anxiety**
- 0 Unable to determine
 - 1 Minimal
 - 2 Expected Amount
 - 3 Predominate behavior
- 44 **Reaction to Anxiety**
- 0 Unable to determine
 - 1 Becomes uncontrollable, falls apart under stress
 - 2 Moves away from anxiety producing situations
 - 3 Uses anxiety constructively
- 45 **Drooling**
- 0 Unable to determine
 - 1 None
 - 2 Moderate
 - 3 Severe
- 46 **Tremors**
- 0 Unable to determine
 - 1 None
 - 2 Moderate
 - 3 Severe
- 47 **Psychomotor Disturbances (Headbanging, Body Rocking)**
- 0 Unable to determine
 - 1 None
 - 2 Mild - occasionally
 - 3 Severe - predominate behavior
- 48 **Comprehension**
- 0 Unable to determine
 - 1 No comprehension of verbal instructions
 - 2 Some comprehension - but not always consistent or dependable
 - 3 Adequate comprehension
- 49 **Speech**
- 0 Unable to determine
 - 1 Delayed
 - 2 Jargon
 - 3 Single words
 - 4 Phrases
 - 5 Sentences

- 50 **Unusual Speech**
- 0 Unable to determine
 - 1 Neologisms
 - 2 Word salad
 - 3 Echolalia
 - 4 None
- 51 **Subjects Attempts to Communicate**
- 0 Unable to determine
 - 1 Obvious verbal communications of thoughts, wants, ideas, messages
 - 2 Attempts to communicate verbally
 - 3 Obvious non-verbal communication
 - 4 No attempts to communicate in any manner
- 52 **Subject's Response to Communication**
- 0 Unable to determine
 - 1 Appropriate Responses
 - 2 Responds sometimes
 - 3 Inappropriate responses
 - 4 No responses
- 53 **Prehension**
- 0 Unable to determine
 - 1 None
 - 2 Reaches
 - 3 Grasps
 - 4 Transfers
 - 5 Crude prehension
 - 6 Fine prehension
- 54 **Cerebral Dominance**
- 0 Unable to determine
 - 1 Left handedness
 - 2 Right handedness
 - 3 Left footedness
 - 4 Right footedness
 - 5 Left eyedness
 - 6 Right eyedness
- 55 **Perceptual Disturbance (Form Board)**
- 0 Unable to determine
 - 1 None
 - 2 Mild
 - 3 Severe
 - 4 Not administered

- 56 Degree of Emotional Disturbance
- 0 Unable to determine
 - 1 No emotional disturbance
 - 2 Inappropriate verbal sounds or words
 - 3 Bizzare behavior - occasionally
 - 4 Bizzare behavior - predominate
- 57 Imagination
- 0 Unable to determine
 - 1 Extremely concrete
 - 2 Minimal fantasy life
 - 3 Much fantasy - dreams, stories, artistic, musical
 - 4 Creative - new uses of tools, toys
- 58 Picture Identification
- 0 Unable to determine
 - 1 None
 - 2 Gestures
 - 3 Points
 - 4 Words
 - 5 Not administered
- 59 Following Simple Commands
- 0 Unable to determine
 - 1 Follows no commands
 - 2 Follows 1 command
 - 3 Follows 2 commands
 - 4 Follows 3 commands
 - 5 Easily
 - 6 Needs constant encouragement and prodding
- 60 Body Parts Identification
- 0 Unable to determine
 - 1 None
 - 2 Several
 - 3 All
 - 4 Not administered
- 61 Building Blocks
- 0 Unable to determine
 - 1 None
 - 2 Tower
 - 3 Bridge
 - 4 Train
 - 5 Gate
 - 6 Steps
 - 7 Not administered

- 62 Solves Formboards
- 0 Unable to determine
 - 1 No
 - 2 Yes
 - 3 Reversed
 - 4 Not administered
- 63 Body Contact
- 0 Unable to determine
 - 1 Moves away from personal contact
 - 2 Perceives people in environment but does not contact and does not respond emotionally
 - 3 Permits body contact but does not encourage it
 - 4 Seeks body contact
- 64 Degree of Emotional Expressiveness
- 0 Unable to determine
 - 1 Apathetic - practically none
 - 2 Mimics expression of others, no feeling involved
 - 3 Shows feelings in response to others
 - 4 Spontaneous expression
- 65 Affection
- 0 Unable to determine
 - 1 Shows no affection under any circumstance
 - 2 Shows affection if given
 - 3 Spontaneously affectionate
- 66 Passiveness
- 0 Unable to determine
 - 1 No passiveness
 - 2 Average
 - 3 Greater than average
- 67 Aggressiveness
- 0 Unable to determine
 - 1 No aggressiveness
 - 2 Average
 - 3 Greater than average
- 68 Destructiveness
- 0 Unable to determine
 - 1 No destructiveness
 - 2 Average amount of destructiveness for age
 - 3 Greater than average

69

Hostility

- 0 Unable to determine
1 No hostility
2 Average
3 Greater than average

Appendix F

Psychological Report Breakdown by Items

<u>Frequency</u>	<u>Item</u>
	1. <u>Intelligence Quotient</u>
36	Not testable by standardized tests
39	Below 20 - profound
25	21-35 - severe
8	36-51 - moderate
6	52-69 - mild retardation
0	70-84 - borderline retardation
1	85 and above - no retardation
	2. <u>Estimated Potential IQ</u>
28	Unable to estimate
60	Same as tested
24	Higher than tested
	3. <u>Social Quotient</u>
0	Unable to determine
37	0-10
37	11-25
18	26-35
13	36-50
4	51-60
1	61-70
0	Above 70
	4. <u>Attention Span</u>
15	Unable to determine
33	Extremely short - flits from one thing to another
21	Short - difficult to hold to a task
29	Average - able to focus attention for duration of task, can maintain attention and yet shift to the next task
16	Prolonged - cannot make transition from one task to another
	5. <u>Motoric Activity</u>
0	Unable to determine
26	Severely hypoactive - just lies or sits
25	Moderately hypoactive - up and locomoting
32	Average - purposeful activity
18	Moderately hyperactive - fidgety and restless
13	Severely hyperactive - moving about almost constantly

<u>Frequency</u>	<u>Item</u>
	6. <u>Persistence</u>
15	Unable to determine
63	None
20	Mild
17	Severe
	7. <u>Reaction to New Situation</u>
2	Unable to determine
25	Withdraws - reluctant, anxious
83	Neutral - unaffected
4	Approaches - unafraid
	8. <u>Degree of Dependency</u>
6	Unable to determine
75	Autonomous functioning - does not feel a need for others
3	Makes continuing efforts unaided when beyond his capacity (unhealthy)
31	Realistic interdependence - seeks help when needs it (healthy)
3	Dependence - seeks help beyond actual need
	9. <u>Stereotypy</u>
1	Unable to determine
100	None
7	Little
7	Much
	10. <u>Ability to Postpone Gratification</u>
3	Unable to determine
74	Can be counted on to delay satisfaction if expected to do so
16	Generally can be expected to wait for rewards if encouraged to do so, sometimes wants immediate satisfaction
8	Generally wants things here and now, impatient about delays, can sometimes wait if encouraged
10	Shows marked inability to postpone present satisfaction for future reward
	11. <u>Response to Sound</u>
1	Unable to determine
10	None
10	Questionable
92	Definite response to sound
	12. <u>Degree of Cooperativeness</u>
1	Unable to determine
9	Yes
19	No

<u>Frequency</u>	<u>Item</u>
	13. <u>Compensatory Use of Senses</u>
1	Unable to determine
9	Yes
19	No
	14. <u>Fear</u>
0	Unable to determine
86	Minimal
25	Expected amount
3	Predominate behavior
	15. <u>Anxiety</u>
0	Unable to determine
81	Minimal
25	Expected amount
7	Predominate behavior
	16. <u>Reaction to Anxiety</u>
2	Unable to determine
8	Becomes uncontrollable, falls apart under stress
9	Moves away from anxiety producing situations
2	Uses anxiety constructively
	17. <u>Drooling</u>
0	Unable to determine
90	None
22	Moderate
3	Severe
	18. <u>Tremors</u>
0	Unable to determine
105	None
6	Moderate
1	Severe
	19. <u>Psychomotor Disturbances</u>
0	Unable to determine
65	None
27	Mild - occasionally
22	Severe - predominate behavior
	20. <u>Comprehension</u>
0	Unable to determine
58	No comprehension of verbal instructions
26	Some comprehension - but not always consistent or dependable
30	Adequate comprehension

<u>Frequency</u>	<u>Item</u>
	21. <u>Speech</u>
0	Unable to determine
63	Delayed
12	Jargon
6	Single words
7	Phrases
22	Sentences
	22. <u>Unusual Speech</u>
1	Unable to determine
0	Neologisms
0	Word Salad
1	Echolalia
	23. <u>Subjects Attempts to Communicate</u>
0	Unable to determine
27	Obvious verbal communications of thoughts, wants, ideas, messages
6	Attempts to communicate verbally
16	Obvious non-verbal communication
63	No attempts to communicate in any manner
	24. <u>Subjects Response to Communication</u>
0	Unable to determine
35	Appropriate responses
24	Responds sometimes
4	Inappropriate response
51	No responses
	25. <u>Prehension</u>
4	Unable to determine
7	None
0	Reaches
9	Grasps
6	Transfers
35	Crude Prehension
53	Fine prehension
	26. <u>Cerebral Dominance</u>
55	Unable to determine
15	Left handedness
43	Right handedness
0	Left footedness
1	Right footedness
0	Left eyedness
0	Right eyedness

<u>Frequency</u>	<u>Item</u>
	27. <u>Perceptual Disturbance</u>
72	Unable to determine
23	None
2	Mild
2	Severe
	28. <u>Degree of Emotional Disturbance</u>
5	Unable to determine
0	Inappropriate verbal sounds or words
27	Bizzare behavior - occasionally
25	Bizzare behavior - predominate
	29. <u>Imagination</u>
15	Unable to determine
73	Extremely concrete
17	Minimal fantasy life
3	Much fantasy - dreams, stories, artistic, musical
1	Creative - new uses of tools, toys
	30. <u>Following Simple Commands</u>
2	Unable to determine
66	Follows no commands
19	Follows 1 command
0	Follows 2 commands
0	Follows 3 commands
16	Easily
0	Needs constant encouragement and prodding
	31. <u>Picture Identification</u>
11	Unable to determine
60	None
2	Gestures
22	Points
6	Words
	32. <u>Body Parts Identification</u>
9	Unable to determine
63	None
	33. <u>Building Blocks</u>
4	Unable to determine
68	None
7	Tower
2	Bridge
2	Train
0	Gate
0	Steps

<u>Frequency</u>	<u>Item</u>
	34. <u>Solves Formboards</u>
21	Unable to determine
43	No
4	Yes
3	Reversed
	35. <u>Body Contact</u>
0	Unable to determine
12	Moves away from personal contact
17	Perceives people in environment but does not contact and does not respond emotionally
32	Permits body contact but does not encourage it
45	Seeks body contact
	36. <u>Degree of Emotional Expressiveness</u>
11	Unable to determine
56	Apathetic - practically none
10	Mimics expression of others, no feeling involved
7	Shows feelings in response to others
25	Spontaneous expression
	37. <u>Affection</u>
15	Unable to determine
36	Shows no affection under any circumstances
28	Shows affection if given
27	Spontaneously affectionate
	38. <u>Passiveness</u>
1	Unable to determine
56	Average
33	Greater than average
16	None
	39. <u>Aggressiveness</u>
1	Unable to determine
50	Average
14	Greater than average
46	None
	40. <u>Destructiveness</u>
1	Unable to determine
29	Average amount of destructiveness
63	No destructiveness
12	Greater than average

Frequency

Item

41. Hostility

4	Unable to determine
19	Average
7	Greater than average
78	None

Appendix G

Psychological Retest Evaluation (N = 16)

<u>Item</u>	<u>Percent of Agreement</u>
Intelligence Quotient	79
Estimated Potential IQ	64
Social Quotient	79
Attention Span	29
Motoric Activity	57
Perseveration	57
Reaction to New Situation	93
Degree of Dependency	64
Stereotypy	71
Ability to Postpone Gratification	57
Response to Sound	86
Degree of Cooperativeness	79
Compensatory Use of Senses	71
Fear	64
Anxiety	64
Reaction to Anxiety	71
Drooling	57
Tremors	71
Psychomotor Disturbances	43
Comprehension	64
Speech	64
Unusual Speech	86
Subjects Attempts to Communicate	71
Subjects Response to Communication	64

<u>Item</u>	<u>Percent of Agreement</u>
Prehension	50
Cerebral Dominance	50
Perceptual Disturbance	93
Degree of Emotional Disturbance	57
Imagination	64
Following Simple Commands	64
Picture Identification	64
Body Parts Identification	64
Building Blocks	71
Solves Formboards	43
Body Contact	50
Degree of Emotional Expressiveness	33
Affection	75
Passiveness	75
Aggressiveness	75
Destructiveness	58
Hostility	<u>83</u>
TOTAL ITEMS	66

Appendix H

ENT Record Form

STAFF DIAGNOSIS: _____ Name of Patient _____
 _____ Cottage _____
 _____ Age _____ yrs. _____ mos.
 _____ Examining Otologist _____
 _____ Date of Examination _____

(Circle appropriate number (1 = "yes" or "positive", 2 = "no" or "negative"))

I. History

A. History of ear disease - - - - - 1 2
 a. Pain - - - - - 1 2
 b. Drainage - - - - - 1 2
 c. Deafness - - - - - 1 2
 d. Surgery (Ear) - - - - - 1 2
 (T. & A.) - - - - - 1 2

Comments _____

B. Family History of Deafness or Ear Disease - - - - - 1 2

Comments _____

C. Prenatal History
 a. Rubella during first trimester - - - - - 1 2
 b. Shock - - - - - 1 2
 c. Ototoxic Drugs - - - - - 1 2

Comments _____

D. Delivery and Postnatal Course

Comments _____

E. History of Head Trauma - - - - - 1 2

Comments _____

F. Central Nervous System Disease - - - - - 1 2

Comments _____

G. Present Medication _____			
II. Physical Examination of the Ears - - - - -		1	2
A. External Canals - - - - -		1	2
Right - - - - -		1	2
Left - - - - -		1	2
Comments _____			
B. Tympanic Membranes - - - - -		1	2
Right - - - - -		1	2
Left - - - - -		1	2
Comments _____			
C. Middle Ears - - - - -		1	2
Right - - - - -		1	2
Left - - - - -		1	2
Comments _____			
D. Ossicular Chain - - - - -		1	2
Right - - - - -		1	2
Left - - - - -		1	2
Comments _____			
E. Gross Hearing Tests - - - - -		1	2
Comments _____			
F. Tuning Fork Tests - - - - -		1	2
a. Weber's Test - - - - -		1	2
b. Rinne's Test - - - - -		1	2
Comments _____			
G. Use of Barany's Noise Box for Masking - - - - -		1	2
Comments _____			
H. Nose - - - - -		1	2
Comments _____			
I. Oral Pharynx - - - - -		1	2
Comments _____			

J. Nasal Pharynx - - - - - 1 2

Comments _____

K. Neck - - - - - 1 2

Comments _____

Impression:

Disposition:

Follow Ups: Date _____

Date _____

Date _____

Appendix I

Otological Categorization of "Impressions"

1. Normal ENT	28
2. Normal Hearing	21
3. Impossible to Assess (No reason given)	6
a. Behavioral	1
b. Mentally retarded	1
c. Structural	9
Total	17
4. Hearing Impairment	
a. Perceptive	18
b. Conductive	19
(1) Cerumen	5
(2) Otitis media	13
(3) Unknown	1
c. Otosclerosis	1
d. Presbycusis	2
e. Multiple medical (2)	7
f. Multiple medical (3)	1
g. Mild hearing loss	1
h. Moderate hearing loss	2
i. Profound hearing loss	3
j. Deafened	1

Appendix J

Otolological Examination Form Results

<u>Item</u>	<u>Positive Finding</u>	<u>Negative Finding</u>
History of Ear Disease	14	49
Pain	5	31
Drainage	14	27
Deafness	10	24
Surgery (Ear)	1	31
(T & A)	24	25
Family History of Deafness or Ear Disease	4	78
Prenatal History		
Rubella during first trimester	1	79
Shock	0	70
Ototoxic drugs	0	70
History of Head Trauma	3	68
Central Nervous System Disease	3	36
Physical Examination of the Ears	27	53
External Canals	26	59
Right	24	58
Left	23	59
Tympanic Membranes	25	72
Right	29	59
Left	28	60
Middle Ears	17	79
Right	17	67
Left	17	64

<u>Item</u>	<u>Positive Finding</u>	<u>Negative Finding</u>
Ossicular Chain	4	72
Right	2	58
Left	3	58
Gross Hearing Tests	47	14
Tuning Fork Tests	20	38
Weber's Test	9	21
Rinne's Test	9	20
Use of Barany's Noise Box for Masking	9	41
Nose	26	84
Oral Pharynx	20	83
Nasal Pharynx	15	83
Neck	4	110

Appendix K
EER-Audio Score Sheet

Evaluator _____ Date _____ Patient _____

I 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____	II 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____	III 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____	IV 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____
--	---	--	---

V 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____	VI 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____	VII 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____	VIII 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____
--	---	--	---

IX 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____	X 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____	XI 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____	XII 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Total _____
---	--	---	--

Appendix L

EER-Audio Ratio Method Score Sheet

Tester _____ Date _____ Patient _____
 Evaluator _____ Time In _____ Age _____
 S.P.O.# _____ Time Out _____ Cottage Number _____

<u>Presentation</u>	<u>20 db</u>	<u>40 db</u>	<u>60 db</u>	<u> db</u>	<u> db</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____
5.	_____	_____	_____	_____	_____
6.	_____	_____	_____	_____	_____
7.	_____	_____	_____	_____	_____
8.	_____	_____	_____	_____	_____
9.	_____	_____	_____	_____	_____
10.	_____	_____	_____	_____	_____
11.	_____	_____	_____	_____	_____
12.	_____	_____	_____	_____	_____
13.	_____	_____	_____	_____	_____
14.	_____	_____	_____	_____	_____
15.	_____	_____	_____	_____	_____
16.	_____	_____	_____	_____	_____
17.	_____	_____	_____	_____	_____
18.	_____	_____	_____	_____	_____
19.	_____	_____	_____	_____	_____
20.	_____	_____	_____	_____	_____

Rating Scale:

1 = No Observable Response
 2 = Possible Response

3 = Probable Response
 4 = Definite Response

Appendix M
Description of Sounds Given in PALI

Name _____ CA _____ MA _____ Sex _____
Test/Retest _____ Judge _____
Group _____

Random Order #1 (db)		Random Order #2 (db)		Random Order #3 (db)	
1	2	1	2	1	2

1	Cow	I'm here		Turn around	
2	Horn	Look here		I'm here	
3	I'm here	Cow		Horn	
4	Turn around	Rattle		Cow	
5	Come on	Come on		Look here	
6	Music box	Music box		Watch out	
7	Whistle	Watch out		Music box	
8	Watch out	Horn		Rattle	
9	Rattle	Whistle		Whistle	
10	Look here	Turn around		Come on	
11	Cow	I'm here		Turn around	
12	Horn	Look here		I'm here	
13	I'm here	Cow		Horn	
14	Turn around	Rattle		Cow	
15	Come on	Come on		Look here	
16	Music box	Music box		Watch out	
17	Whistle	Watch out		Music Box	
18	Watch out	Horn		Rattle	
19	Rattle	Whistle		Whistle	
20	Look here	Turn around		Come on	

1 = No response
2 = Response

Appendix N
Responses Identified

Looking in direction of speaker or pointing at the speaker

Looking for the sound even if not at the right speaker

Eye movement at the time of sound or shortly thereafter in the expected
direction

Cessation of movement, placing hand to ear, or turning around

Change in behavioral pattern, i.e. turning in response to command to turn,
beginning to move when previously quiet, when timed into sound

Increase in crying

Looking at judge or at panel operator to see if they made the sound involved

Close attending to judge's mouth to locate sound source

Quick head turn, turning of the head as if to cock it for listening, or
head turn even if delayed if in right direction

Shaking head and/or smiling during the time sound was on

Sudden body tensing, or sudden startle response

Asking "what" after the sound, repetition of the sound, or any verbal or
motor reply to sound

Shaking of the head, saying "aaagh", or other "distasteful reaction" to sound

Hand clap, wiggling in tune, or waving of feet to rhythm of horn, rattle

Interrupted response, i.e. began to smile, then stopped when the sound
came on



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